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CONTENTS

		PAGE
Trichogramma Experiments in 1928 for Control of the Sugarcane Borer	*W. E. Hinds* and *Herbert Spencer*	633
Codling Moth Bait Trap Studies	*L. F. Steiner*	636
Miscellaneous Codling Moth Studies	*L. F. Steiner*	648
A Determination of the Lethal Dosage of Arsenic for Missouri and Colorado Codling Moth Larvae	*Leonard Haseman* and *Virgil F. Burk*	655
Citrus Canker Eradication	*K. F. Kellerman*	656
Hydrated Lime in Summer Sprays for the Control of the Oriental Fruit Moth	*L. A. Stearns* and *R. B. Neiswander*	657
The Bud Moth in Western New York	*S. W. Harman*	660
Thermotropism of the Mexican Cotton Boll Weevil	*Edgar F. Grossman*	662
Attempts to Protect Sweet Corn from Infestations of the Corn Ear Worm, (*Heliothis obsoleta* Fabr.)	*Stanley B. Freeborn* and *Floyd H. Wymore*	666
Observations on the Carrot Rust Fly (*Psila rosae* Fab.) in Massachusetts	*W. D. Whitcomb*	672
Banding for Codling Moth Control	*W. P. Flint* and *C. C. Goff*	675
Spraying for the Control of Onion Thrips in Massachusetts	*A. I. Bourne*	679
The Onion Maggot Situation in New York	*Hugh Glasgow* and *Harold T. Cook*	683
Pyrausta nubilalis Hubn. in Europe: Notes on Infestation and Parasitism from 1926–1928	*H. L. Parker, A. M. Vance, H. D. Smith* and *W. Gambrelidze*	688
Facilitating the Removal of the Spray Residue	*R. H. Robinson*	693
The Apple Aphid and the Citrus Aphid: *Aphis pomi* DeGeer and *A. spiraecola* Patch	*Edith M. Patch*	698
United States Insecticide Statistics for 1928	*R. C. Roark*	699
A Short Review of Economic Entomology in Finland	*Uunio Saalas*	701
Scientific Notes		704
Editorial		707
Reviews		709
Current Notes		710
Horticultural Inspection Notes		723
Apicultural Notes		725
Notes on Medical Entomology		728

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VOL. 22 AUGUST, 1929 No. 4

TRICHOGRAMMA EXPERIMENTS IN 1928 FOR CONTROL OF THE SUGARCANE BORER

By W. E. HINDS and HERBERT SPENCER, *Louisiana Experiment Station*

ABSTRACT

Using *Sitotroga cerealella* as host, more than sixteen million parasites of the species *Trichogramma minutum* Riley were reared in the laboratories of the Louisiana Experiment Station. These parasites were used experimentally in fields of corn and sugarcane for control of the sugarcane borer, *Diatraea saccharalis*. Colonizations of *Trichogramma* during June 1928 in five localities resulted in marked increases in percentages of *Diatraea* eggs parasitized.

In September 1925, study on the egg parasite, *Trichogramma minutum* Riley, was started at the Louisiana Experiment Station, in connection with the Sugarcane Borer Control Project. Early in the work it was appreciated that *Trichogramma* is the most important biological control factor, in spite of one limitation—the fact that it does not usually begin its attacks on *Diatraea* eggs before the last of June and is not present in all of the fields of sugarcane and corn until the fall months. It was thought that if the parasites were bred artificially, were kept through the winter in the laboratory, and were introduced early in the season into infested fields of corn and sugarcane, that early natural multiplication of *Trichogramma* in colonized areas would reduce the infestation and damage by the sugarcane borer.

Accordingly, laboratory rearing of *Trichogramma* was commenced March 1927, utilizing eggs from laboratory-bred *Sitotroga cerealella* moths. The technique of rearing and the results of a small scale colonization experiment conducted in 1927 have been reported previously.[1]

With improved technique and enlarged rearing rooms, more than sixteen million parasites were bred in 1928, and experiments on a much larger scale were conducted.

[1]Hinds, W. E., and Spencer, Herbert. Utilization of *Trichogramma minutum* for Control of The Sugarcane Borer. Journal Economic Entomology, Volume 21, No. 2, pp. 273–278, 1 plate; April, 1928.

Beginning April 19, 1928, *Trichogramma* colonizations were made in fields of garden corn, field corn and sugarcane, timed to coincide with the first egg-brood of *Diatraea*. In four localities, 275,000 parasites in all were liberated and at later dates *Trichogramma*-parasitized cane borer eggs were recovered in three of these places. However, there was no subsequent increase of parasites in the fields, since the first brood eggs were unusually scarce in 1928, a year of light infestation. And in the interval between first and second egg broods, the established colonies evidently died out for lack of suitable host eggs, because no trace of parasitism was seen in those fields, when the second brood eggs became abundant.

The colonization experiments upon second brood eggs were much more successful. In June, four localities in different parts of the "Sugar Belt" were selected, and in each locality two similar fields were found, one for colonization with the *Trichogramma* parasites, and one to serve as an uncolonized check area. In these experiments and in several special colonizations for other purposes, 258,000 parasites were liberated. At intervals during the growing season, collections of cane borer eggs were made, both in the colonized and in the check areas, and the percentages of parasitism were determined and compared. The detailed colonization data and results are tabulated below:

In the course of these experiments, requests for *Trichogrammas* have come from several investigators in other states and countries, who desired breeding stock to start similar work on other crop pests. These have been complied with in every case, and successful shipments have been made by mail to Oregon, Massachusetts and the Dominion of Canada, as well as places nearer Louisiana. A total of 253,000 *Trichogrammas* have been distributed in this manner.

Literally millions of the *Trichogrammas* have been used in the routine rearing, in laboratory experiments for the purpose of improving production, for miscellaneous field tests on times and methods of liberation, on dissemination after colonization, and the like. The data are so detailed, that only a few results can be summarized here.

Preparations for the 1929 experimental work were started November 1, 1928, by thoroughly cleaning out all production facilities, and by fumigating with calcium cyanide. The *Sitotroga* rooms were restocked with new corn, previously fumigated and *Sitotroga* eggs are being added daily to build up an infestation. The stock of *Trichogramma* parasites is being held to a minimum just large enough to insure against total loss during the winter, and increase will not be attempted until one month prior to the first field colonizations.

TABLE 1. TRICHOGRAMMA COLONIZATIONS, 1928

Location	Colonized Date 1928	Parasites Released	Crop	Percentage of Eggs Parasitized[1] Date 1928	Check Field	Colonized Field
Berwick, La.	5/17	10,000	Cane	4/25	0	0
			"	6/13	0	0
			"	7/5	0	23.6
			"	7/27	5.8	52.0
			"	9/6	20.0	57.3
			"	10/16	96.1	100.0
Franklin, La.	5/29	10,000	Corn	7/28	0	33.2
			"	9/5	16.7	89.9
			Cane[2]	10/15	88.8	88.9
Napoleonville, La.	6/21	10,000	Corn	7/31	0	50.0
			"	9/7	0	97.2
			"	9/8	5.4	92.1
Baton Rouge, La. (Cuts 6, 7)	6/23	10,000	Corn	7/19	0	0
			"	8/1	0	23.6
			Cane[2]	8/21	0	40.3
			"	9/4	10.5	34.9
			"	9/11	32.4	53.0
			"	9/19	67.6	63.8
			"	10/16	91.1	99.8
Baton Rouge, La. (Cuts 12, 13)	6/7 to 6/23	94,000	Corn	6/29	0	5.6
			"	7/2	0	14.9
			"	8/3	0	23.9
			Cane[2]	9/5	0	5.1
			"	9/13	0	10.1

[1]27,209 *Diatraea* eggs examined for these records.

[2]In cases where corn was dry and no longer available, the nearest cane was substituted.

The writers wish to express their indebtedness to several workers who have assisted greatly in the 1928 work. Mr. C. O. Hopkins has carried on the laboratory production most successfully, and has performed many of the miscellaneous experiments. Mr. B. A. Osterberger and his Student Assistants have made the egg collections in the colonizations, and Mr. C. L. Stracener has supervised the construction of all rearing apparatus. The authors desire also to thank the many Sugar Planters who have shown their interest in the experiment by furnishing fields for the colonizations and in two instances by building supplementary *Trichogramma*-production plants. (Sterling Sugars, Inc., Franklin, La., and The South Coast Company, Marrero, La.)

Summary and Conclusions

1. With enlarged rearing facilities, more than sixteen million *Trichogrammas* were produced in the Louisiana laboratories in 1928. These were used in routine rearing, miscellaneous laboratory and field experiments, distribution to other investigators, and in field colonizations.

2. *Trichogramma* colonies were successfully established in sugar-cane and corn during the first egg-brood period of the sugarcane borer, but died out, because of the unusual scarcity of first brood eggs in 1928, a year of light infestation.

3. *Trichogramma* colonizations upon second brood eggs resulted in significant increases in percentages of parasitism in several experiments. The differences in percentages of parasitism between colonized and uncolonized "check" fields were sustained until late fall, when all fields reached the nearly total parasitism attained much earlier in colonized fields.

4. Spread of the parasites after colonization is slow, except in the direction of prevailing winds. It is preferable, therefore, to place the parasites on the windward side of the area to be colonized.

5. Colonizations with a large number of parasites (94,000) in a limited area, were not superior in results to colonizations with smaller numbers (10,000). Where large numbers of parasites are available it is deemed better at present to distribute them well over the area selected, in increments of two or three thousand to a small section. It seems preferable to liberate on several successive dates, rather than at only one time.

6. The ability of *Trichogramma* to sustain itself, spread and increase in numbers and effectiveness evidently depends largely upon the availability of host eggs. In years of heavy infestation and host egg-production, *Trichogramma* colonizations would be most beneficial, therefore.

CODLING MOTH BAIT TRAP STUDIES[1]

By L. F. Steiner, *Purdue University Agricultural Experiment Station, Lafayette, Indiana*

Abstract

A low grade molasses solution to which geraniol has been added has proven the most attractive bait for codling moths (*Carpocapsa pomonella*), among the large number of ferments, aromatic chemicals, and ferment-chemical combinations tested during 1927 and 1928. It is particularly attractive during the dry summer months. Aromatic chemicals used alone were of no value under Indiana conditions.

The use of bait traps as a supplementary control was proven uneconomical where the injury can be held to 10 per cent or less by banding, orchard sanitation, or other

[1]Contribution from the Department of Entomology, Purdue University Agricultural Experiment Station.

means, since it cost $86.00 to produce 80 bushels more clean fruit in a 12-acre experiment. The results secured, however, are promising enough to warrant further tests in more heavily infested orchards.

Bait traps captured more individuals than did bands. Females outnumbered males during the summer months but in cool weather more males were captured. Many eggs were deposited despite the fact that 95 per cent of the females were gravid or partly so. Unless the trap was exposed more eggs were deposited on baited trees than on those containing no traps.

Position of the trap was as important a factor in determining its efficiency as the attrahent it contained. The best traps were located in the extreme top of trees or high up on the outside; were exposed rather than hidden by foliage; and were located in the higher parts of the orchard. Without sufficient exposure many pans, otherwise properly located, caught few or no moths.

Thousands of other destructive insects were captured by the traps. With a few exceptions beneficial forms were comparatively rare.

The results secured in the western apple growing districts from the use of attractive baits as a supplementary control for the codling moth aroused the interest of many growers in the central west and led us to include in our investigation a study of such baits under Indiana conditions.

The writer was assisted by C. O. Mohr in 1927, and L. H. Townsend in 1928.

Methods

With some variation, the type of container and methods used by Yothers[2] were employed. Three-quart gray enamel stew pans, nine inches in diameter and three inches deep containing the baits were pulled up into the tops of the trees and lowered for examination by a heavy white cord which was run through two one-half inch screw eyes placed a foot or more apart on nearly horizontal limbs. To prevent tipping a wire was run from the bail to one side of the pan. A small hole punched in the pan below the rim permitted the escape of excess liquid during heavy rains, and prevented captured moths from being washed out. Tin cans were used in a few tests for comparison.

Weather conditions and number of other insects captured governed the length of time between examinations and renewal of the baits. As a rule they were examined five to seven times monthly and solutions completely renewed every two to three weeks. Water was added to the bait pans whenever necessary to compensate for loss by evaporation.

In all the 1927 experiments different tests were separated as much as possible, there being about two sets, or eight to ten pans per acre.

[2]Yothers, M. A. Proc. Wash. State Hort. Assn. 22:53–62, 1927.

Containers holding the same solution were usually hung in adjacent trees. A few tests were duplicated in distant parts of the baited area.

Experiments in 1927

The first series of tests was conducted in the orchard on the Purdue Farm near Bedford. This is a 60-acre orchard containing a mixture of many varieties. All of the trees baited had reached full bearing capacity.

Among the materials tested were the aromatic chemicals that gave the best results in the Colorado[3] experiments. Some of the constituent odors of ripe apples such as amyl formate, amyl caproate, amyl acetate, acetaldehyde, and geraniol, suggested by Dr. H. R. Kraybill, Indiana State Chemist, were also included. Fermenting baits demonstrated their superiority to aromatic chemicals early in the season. For this reason later in the summer in the second series of tests only ferments, some with aromatic chemicals added, were used.

The results secured by the use of bait traps during the period of spring-brood emergence were for the most part unsatisfactory. Only 537 moths were captured while the total number of trap days amounted to 9,782. This figure is arrived at by multiplying the number of pans used by the number of days they were in operation. The results of a few of these tests are reported in Table 1.

Table 1. Relation of Position in Tree to Number of Moths Caught. Purdue Farm, Bedford, Ind. May 17–July 29, 1927

Test	Location and Type Container Used	Number Containers	Moths Captured		
			Males	Females	Total
1	Stew pans in tree tops	5	31	28	59
2	Stew pans on N. E. side of tree, half way up	5	16	20	36
3	Stew pans on S. W. side of tree, half way up	5	14	22	36
4	Stew pans on N. E. side of tree, near ground	5	3	4	7
5	Stew pans on S. W. side of tree, near ground	5		1	1
6	Stew pans in tree tops, two per tree	4	17	25	42
7	Stew pans in tree tops, low ground	5	10	7	17
8	Tin cans in tree tops (quart size)	5	33	36	69

Notes: Ten per cent (by volume) low grade New Orleans "blackstrap" molasses plus one-half cake dry yeast per gallon solution, was used in all tests reported above.

The trees in which Test 8 was located all escaped the late frost injury and were full of fruit. Many different varieties were baited but most of them failed to set fruit because of late frost injury.

Moth emergence began May 2, but baits were not started until May 17.

Only one container was used to a tree in all instances except Test 6. Approximately one quart of bait solution was maintained in the pans.

[3]Yetter, W. P. 16th Ann. Rept. St. Ent. of Col. 32–37, 1924.

Only three of the many other solutions tested equaled the low grade molasses in attractiveness during the period over which they were used. These were low grade molasses plus one cc. ethyl propionate per pan, low grade molasses without yeast, and 10 per cent medium grade molasses plus one cc. geraniol per pan. Ethyl propionate was the most attractive chemical when used alone. However, it was only 25 per cent as attractive as the low grade molasses ferment (Table 1). Many of the other aromatic chemicals failed to catch any moths.

Ferments tested include those prepared with low, medium, and high grade molasses, honey, hard cider plus brown sugar, apple,[4] brown sugar allowed to stand 10 days before using, malt, beer, tomato, and syrup from canned pears, peaches, and plums. Some were used with and some without yeast. All were tested in stew pans located in the tops of trees. Low grade molasses was also tested in stew pans and tin cans painted with white lead.

Aromatic chemicals or essential oils tested include ethyl propionate, iso-amyl caproate, geraniol, bromo styrol, benzol benzoate, safrol, iso-butyl-phenyl acetate, amyl formate, amyl acetate, acetaldehyde, combinations of geraniol with amyl formate, and geraniol with acetaldehyde. Some of these were used in the Peterson[4] type trap. Many were used in pans containing a 10 per cent granulated sugar solution. Glycerin was added in some instances. One cubic centimeter of the chemical was used in all tests.

Chemical ferment combinations included high grade molasses plus one cc. amyl caproate, medium grade molasses plus geraniol, tomato ferment plus ethyl propionate, cider plus ethyl propionate, and plum ferment plus geraniol.

When ethyl propionate or geraniol was added to the molasses ferments the attractiveness was increased considerably. Therefore the solutions tested in the Burton Fruit Company Orchard (Table 2) during the summer months were mostly chemical-molasses combinations.

While tin cans appeared better than stew pans as containers during the early part of the season they did not prove as efficient during the second series of tests. New cans were used in each test. In both series their attractiveness decreased after they became rusty.

The difference in the number of moths caught by pans containing the same solution, and often located in adjacent trees, emphasizes the necessity of a large-scale test for dependable conclusions.

[4]Peterson, Alvah. Jour. Econ. Ent. 19:863–866, 1926.

TABLE 2. RESULTS OF ALL BAITS TESTED IN THE BURTON FRUIT CO. ORCHARD, ORLEANS, IND., DURING THE SUMMER OF 1927

Test	Description of Solution, etc.	Duration of Test	Codling Moths Captured		
			Males	Females	Total
1	10% hard cider solution plus ½ lb. brown sugar and ½ cake dry yeast per gallon.	July 22 to Oct. 4	23	92	115
2	10% brown sugar solution plus ½ cake dry yeast per gallon.	July 23 to Oct. 4	10	49	59
2a	10% brown sugar solution allowed to stand 10 days before using.	Aug. 9 to Oct. 4	8	19	27
3	10% high grade molasses plus 1 cake dry yeast per 3 gallons.	July 22 to Oct. 4	3	37	40
3a	Solution 3 plus 1 cc. geraniol per pan.	do	4	24	28
4	10% medium grade molasses plus 1 cake dry yeast per 3 gallons.	do	10	19	29
4a	Solution 4 plus 1 cc. geraniol per pan.	do	7	19	26
4aa	Solution 4a, located on higher ground.	Aug. 9 to Oct. 4	14	72	86
5	10% low grade molasses plus 1 cake dry yeast per 3 gallons.	July 23 to Oct. 4	12	67	79
5a	Solution 5 in containers painted white.	do	15	38	53
5b	Solution 5 in containers with vertical obstructions.	do	12	30	42
5c	Solution 5 in tin cans.	do	21	45	66
5d	Solution 5 plus 1 cc. geraniol per pan.	do	13	47	60
5e	Solution 5 plus 1 cc. acetaldehyde per pan.	do	36	124	160
5f	Solution 5 plus 1cc. amyl caproate per pan.	do	19	77	96
5g	Solution 5 plus 1 cc. amyl formate per pan.	do	8	35	43
5h	Solution 5 plus 1 cc. ethyl propionate per pan (low ground)	do	5	39	44
5i	Solution 5 plus 1 cc. benzol benzoate per pan (low ground).	do	5	17	22
5j	Solution 5 plus 1 cc. safrol per pan (low ground).	do	5	13	18
5k	Solution 5 plus 1 cc. bromo styrol per pan (low ground).	do	20	39	59
5l	Solution 5 plus 1 cc. amyl acetate per pan.	Aug. 9 to Oct. 4	3	28	31
5m	Solution 5 plus hard cider 1–10	Aug. 9 to Oct. 4	9	40	49
6	10% low grade molasses without yeast.	July 22 to Oct. 4	43	128	171

TABLE 2.—*Continued*

Test	Description of Solution, etc	Duration of Test	Codling Moths Captured		
			Males	Females	Total
6a	Solution 6, lower ground.	Aug. 9 to Oct. 4	16	54	70
6b	Solution 6 plus 1 cc. geraniol per pan.	July 22 to Oct. 4	69	175	244
6ba	Solution 6b on low ground.	Aug. 9 to Oct. 4	4	21	25
6c	Solution 6 plus hard cider 1–10.	do	8	36	44
6d	Solution 6 plus 1 cc. ethyl propionate per pan.	do	13	57	70
6e	Solution 6 plus 1 cc. acetaldehyde per pan (low ground).	do	7	35	42
6f	Solution 6 plus 1 cc. amyl formate per pan (high ground).	do	11	63	74
6g	Solution 6 plus 1 cc. amyl caproate per pan (high ground).	do	13	67	80
7	5% low grade molasses plus 1 cake dry yeast per 3 gallon (high ground).	July 23 to Oct. 4	44	117	161
7a	Solution 7 on low ground.	Aug. 9 to Oct. 4	22	63	85
7b	Solution 7 plus hard cider 1–5.	do	10	45	55
8	5% low grade molasses without yeast.	do	23	52	75
8a	Solution 8 plus 1 cc. geraniol per pan.	do	21	82	103
8b	Solution 8 plus hard cider 1–5 (low ground).	do	5	21	26
Total: Number containers 148. Trap days 9,744.			571	1986	2567

Note: Four containers were used in all tests, one per tree. Three-quart stew pans were used except where otherwise stated. All pans were kept from one-half to two-thirds full of the solution. Solutions were made up to the per cent stated by volume in the case of molasses and cider, and by weight where sugar was used.

Some of the more attractive solutions were continued but no moths were captured after October 8.

Only Jonathans, a few Rome Beauties, and one Winesap, all containing fruit, were baited.

EXPERIMENTS IN 1928

Experiments conducted in 1927 indicated that a low grade molasses solution plus geraniol was among the most attractive used. Ten per cent molasses alone gave considerable promise. These two solutions were used again in 1928. Yeast was added during May and June but better results were secured by not using it in warmer weather when fermentation would ordinarily start within a few hours.

Citronellal was substituted for geraniol in a few of the pans. For a few weeks early in the season a five per cent solution was used in half

the baits of each set. It proved much less attractive then than the ten per cent baits due probably to its excessive dilution by frequent rains. During August when again tried, five per cent equaled the ten per cent in attractiveness, both with and without the aromatic chemicals.

For the 1928 experiment an area within the Burton Fruit Company Orchard, containing about 12 acres, was used. The orchard extended one-fourth mile to the north and to the east, 100 yards to the south, and 200 yards to the west from the edge of the baited area. Varieties ran north and south in alternate blocks of four rows each. The area was 20 rows wide and 24 rows deep. It included two blocks of Jonathans, two blocks of Winesaps, and through the center a block of Rome Beauties, with the latter variety bounding the area on the east and west.

Solutions A and B (Table 3) were placed in rows across the area and alternated every two rows. In two of the rows crossing the center of the area, solution C was substituted for B. Stew pans were hung in every other tree except where trees were missing or where one tree did not permit as good a location for the pan as an adjacent one.

Because of the absence of many trees particularly in the lower ground there were but 393 within the area suitable for trapping. Among these were distributed 210 traps. Ten traps across the area were suspended between trees while five within the area were hung from one to two feet above the highest part of the tree and completely in the open. Those between trees varied from eight to fifteen feet above ground and hung from three to eighteen feet away from the nearest foliage, depending upon the height and diameter of the trees between which they were hung.

TABLE 3. RELATIVE ATTRACTIVENESS OF BAITS USED FROM MAY 15 TO OCTOBER 1, 1928, BURTON FRUIT CO. ORCHARD, ORLEANS, IND.

Solution	Number Containers	Moths Captured			
		Males	Females	Total	Av. per Pan
A—10% low grade molasses...	103	177	186	363	3.52
B—Solution A plus 1 cc. geraniol per pan.....	79	147	242	389	4.92
C—Solution A plus 1 cc. citronellal per pan.....	18	41	52	93	5.16
D—Solution B suspended between trees.....	10	22	29	51	5.10
Number trap days 28,980 Total	210	387	509	896	4.27

Notes: Spring-brood moth emergence began May 17 and ended about July 6. First-brood moth emergence did not begin until July 15.

Severe winds and rain storms emptied many of the pans on several occasions. For this reason the above records do not represent all the moths captured by the baits.

It can be seen from Table 3 that the addition of aromatic chemicals to molasses noticeably increased the attractiveness of the solution. In this connection it is important to note that the chemical-molasses combination was no better than molasses alone during the cool rainy spring but during the hot dry summer it proved to be twice as efficient.

Commercial Value of Bait Traps

Infestation records were secured from Jonathans in July and from all three varieties at harvest by examining 100 apples from the bottom and 100 from the top of over 200 average trees within and surrounding the baited area.

The Jonathan counts made in July on 52 trees showed that 98.9 per cent of the fruit was uninjured on baited trees and 98.0 per cent on unbaited trees within the area while outside 97.8 per cent of the fruit was uninjured. These counts indicate that the bait traps were of little if any value during spring brood emergence. Excessive rains during the spring were doubtless partly responsible for their ineffectiveness.

The yield records and the infestation records (Table 4) secured at harvest indicate that the bait pans were responsible for an increase of only 80 bushels in the amount of uninjured fruit produced in the 12 acre baited area.

Table 4. Harvest Infestation Records in the Burton Fruit Co. Orchard, 1928

Location	Variety	No. Apples	Number Worms	Number Stings	Percentage Fruit Wormy	Percentage Fruit Stung	Percentage Fruit Sound
Baited area	Jonathan	1800	42	72	2.22	3.22	95.05
Unbaited trees	Rome Beauty	1800	57	195	2.77	8.00	90.11
	Winesap	1800	20	101	.83	4.16	95.00
Baited area	Jonathan	2200	54	93	2.31	3.68	94.59
Baited trees	Rome Beauty	2200	52	170	2.45	5.95	92.54
	Winesap	2200	19	84	.72	3.13	96.31
Baited area	Jonathan	4000	96	165	2.27	3.47	94.80
Average	Rome Beauty	4000	109	365	2.37	6.87	91.45
	Winesap	4000	39	185	.77	3.70	95.72
Surrounding	Jonathan	6400	230	306	3.75	4.78	93.12
area	Rome Beauty	6000	294	675	3.88	8.46	88.40
Average	Winesap	6000	111	387	1.61	4.73	94.08

Note: Jonathans produced a full crop; Rome Beauty about 60 per cent; and Winesap about 30 per cent.

Complete cost records for this experiment were maintained. Table 5 represents an estimate of the cost of such a project to the grower based

on our experience. In this estimate stew pans are considered as having a life of four years. The labor involved in the operation of the pans has been cut in half, since the average grower would not take the time to search out the codling moths among the mass of other insects, except perhaps early in the season when the information on the numbers appearing would be of value in timing his sprays. Labor should not cost over 20 cents per hour in southern Indiana since a boy can handle the traps. Geraniol need not be used in the pans until July, and citronellal, a cheaper material, could be substituted.

TABLE 5. COST RECORDS FOR BAIT TRAPS FROM MAY 15–OCTOBER 1, 1928

Item		Cost to Grower
Capital		
210 3-quart gray enameled stew pans @ $31.80 per gross	$46.20	$11.55
No. 12 wire for bracing pans	.40	.10
Annual Replacements		
13 lbs. No. 36-42 white seine cord or staging @ 68c per lb.		9.44
2 lbs. 8 p. nails @ 6c		.12
70 gals. New Orleans "blackstrap" molasses @ 25c gal.		17.50
1000 grams geraniol @ $1.00 per 100 grams		10.00
Labor		
Wiring pans from lip to bail—5 hours @ 25c per hour	1.25	.32
Hanging pans in trees—38 hours @ 25c per hour		9.50
Operation and caring for pans during spring and summer months—137 hrs. @ 20c per hour		27.40
Total		$85.93

The test was not economical because the cost of producing the 80 bushels of sound fruit amounted to $85.93. The value of the bait traps, as an aid in timing the spray applications, has not been considered but is nevertheless important. Only a few traps would be needed for this, however.

Where the injury can be held to 10 per cent or less by other means, bait traps will probably be of no value as a control. Nevertheless the possibilities for increasing their efficiency are great and this means of control deserves further investigation where the moth population is larger.

It is significant that prior to September 1, from 214 crepe paper bands placed on scraped trees in the more heavily infested parts of the area, the grower captured less than half as many first- and second-brood worms as the bait traps did moths of the same broods. The captured moths were those that had developed from larvae which escaped the bands.

Miscellaneous Factors

Factors Indirectly Affecting the Catch of Moths: A factor which influenced the catch in all tests was the clean-up campaign in progress in both orchards where bait traps were used. In the Purdue Orchard the severe infestation in 1926 led to the initiation of an intensive clean-up campaign. Approximately 10,000 moths were destroyed in the packing house in the spring of 1927 and the cool rainy spring of that year, together with an almost total crop failure, made the clean-up campaign doubly effective; so effective in fact that the bait trap experiment there had to be discontinued at the end of spring-brood moth emergence.

The Burton Fruit Company Orchard offered the best possibilities for a continuation of the experiment. This orchard in 1926 produced a 60,000 bushel crop which averaged two worms and over ten stings per apple. The packing shed held 40,000 to 50,000 moths, and an even more intensive clean-up campaign than in the Purdue Orchard, was carried out. The result was that at harvest in 1927 the small crop showed an average of three-tenths worms and two stings per apple. Aided by natural factors such as 40 per cent parasitism by *Trichogramma minutum* late in August, a high winter mortality, and weather unfavorable for codling moth development in the spring of 1928, the growers were able to reduce the codling moth population still further so that at harvest only 3.5 per cent of the 55,000 bushel crop was wormy (Table 4). All of these factors had an important bearing on the value of bait traps as shown in the results.

Ratio of Males to Females Captured: During the period of spring-brood emergence at Bedford in 1927, 51 per cent of the codling moths captured were females. In May males greatly exceeded the females.

During the period of first- and second-brood emergence at Orleans, 77.3 per cent of the 2,567 moths captured there were females. The number of males did not begin to exceed the number of females appearing in the traps until late September, and at no time from July 22 to September 10 did the males exceed 35 per cent of the moths captured.

During spring-brood emergence in 1928, only 37.6 per cent of the moths captured were females, while in July, August and September, 67.6 per cent were of this sex, the average for the season being 56.8 per cent. The geraniol-molasses combination not only caught more moths but it averaged 11 per cent more females than did molasses alone.

Insectary records and examinations made in packing houses, indicate that there was seldom more than five per cent difference in the numbers

of each sex emerging at any time. The reason for the preponderance of males appearing in the traps in early spring and fall seems to be due to one or two factors. Either the males are active at lower temperatures than the females or a change in the temperature alters the relative attractiveness of the bait solution to the two sexes. That temperature is concerned seems certain since an increase in proportion of males to females always accompanied a period of cool weather.

BAIT TRAPS VERSUS EGG DEPOSITION: Approximately 95 per cent of the females captured contained a part or all of their eggs. It seems probable, however, that many more eggs are deposited by moths before they are captured than is generally believed.

Late in August, 1927, when the season's egg deposition was at its peak, counts were made on a number of baited and unbaited trees. A total of 1,900 apples on ten trees were examined and the average number of eggs per 100 apples determined. Trees of a uniform size, prospective yield, and the same variety were selected for comparison.

Two Jonathan trees containing the 6b solution (Table 2) and located on high ground, averaged 30 eggs per 100 apples. Two adjacent unbaited trees averaged 14 eggs, while in low ground, a tree containing the same solution averaged 27 eggs per 100 apples. An unbaited tree 60 feet from the latter averaged but 11.5 eggs per 100. Thus on 500 apples from baited trees were found 144 eggs while on 600 apples from nearby unbaited trees there were only 79 eggs. The foliage on all of these trees was rather dense and although the pans were located in the extreme top, they were partly hidden.

In another part of the orchard 200 apples were examined on a Winesap tree (Fig. 1) which contained a pan that captured 56 moths from August 9 to September 20. Only three eggs per 100 apples were found. On adjacent Winesaps, 27 eggs were found on 400 apples, almost twice as many per 100 as on the baited tree. The pan was located in the extreme top of the Winesap, was well exposed, and the foliage on the tree was not dense.

The examinations indicate that—1, During the hot part of the season bait pans attract moths from surrounding trees; 2, moths attracted will go to the pans directly if the latter are properly located; 3, if a pan is hidden by foliage moths will stop to deposit a part or all of their eggs before they filter through to the bait and; 4, they may fail to find the pan even though attracted to the tree in which it is located.

RELATION OF POSITION TO BAIT TRAP EFFICIENCY: Reference to Table 3 will show that solution 6b on high ground captured 244 moths

but on low ground only 25, yet moths were ovipositing at an equal rate on trees in both sets. This fact, as well as the wide variation in the number of moths caught by different traps in the same set, led to a study of the factors relating to the location of the traps which might have influenced the catch.

The study shows that the most important factors to be taken into consideration in so far as is possible when placing bait traps are as follows:

1. The trap should be located in the extreme top center of the tree. This has been stressed by various investigators. If impossible to so place it, the trap should be located as high as possible on the extreme outside of the tree.

2. The density of foliage above and surrounding the pan may be important enough to make trapping useless unless it is taken into consideration. Traps hidden by foliage were far less efficient than those in an exposed position. However, some foliage near the pan seems essential for the five pans hung above the trees in 1928 averaged no better than their neighbors. Of the pans hung between trees those highest and at the same time nearest to one of the trees between which they hung, gave the best results. Height in the tree is very important but no more so than exposure.

3. The elevation of a baited tree in an orchard where the topography is uneven seems important. Although there was only a difference of 25 feet in elevation of different parts of the baited area, only one of the 35 best traps in 1928 was located in low ground, while nine of the twelve which caught no moths were in this position, the other three being on a slope. A comparison of the results secured from the duplicate sets listed in Table 2 will illustrate this point. Infestation counts showed only a slightly larger worm population on ridges than in the hollows.

4. The size of tree is important where small and large trees adjoin each other but traps located in an area of small trees were found to be just as effective as those in an area of large trees, other things being equal.

Other Insects Caught in Bait Traps: The molasses-geraniol combination was especially attractive to the green June beetle, (*Cotinus nitida*). From July 22 to August 14, 1927, and from July 14 to September 10, 1928, over 20,000 were captured, there being on some occasions as many as 350 beetles in a trap at one examination.

Thousands of Noctuids appeared, among them several hundred army worm moths (*Cirphus unipuncta*).

Cicada killers (*Sphecius speciosus*) were very common in all the molasses baits. Molasses alone was very attractive to Nitidulids, several thousand *Glischrochilus* (*Ips*) *fasciatus* being captured.

Ethyl propionate in a honey and sugar solution was attractive to Elaterids.

Hundreds of different species were captured in the pans, many of them beneficial. Destructive insects, however, far out-numbered the beneficial forms.

MISCELLANEOUS CODLING MOTH STUDIES[1]

By L. F. STEINER, *Purdue University Agricultural Experiment Station, Lafayette, Indiana*

ABSTRACT

Only three per cent of the larvae captured in bands treated with beta-naphthol completed their life cycle and emerged as moths. Field tests and behavior studies indicate that this chemical repels 10 to 20 per cent of the larvae. Alpha-naphthylamine (Techn.) used in a similar manner gives promise of being as effective as beta-naphthol.

Corrugated strawboard proved the best material for chemical treatment while a combination burlap and kraft paper is more efficient than burlap, crepe, or tar paper where untreated bands are used. Thickness was found to be an important factor in determining the efficiency of any banding material.

Mature larvae are attracted to upright objects and find the tree readily in daylight but only by accident at night.

Although able to successfully hibernate in leaves and in sod, larvae will not readily do so if coarse debris is present or if adequate cocooning quarters such as bands are available on the trunk. Small shrubs and bits of dead weed stems in the absence of coarse debris furnished attractive cocooning quarters for larvae.

Larvae can live in buried apples for at least seven weeks, and before the soil is too solidly packed can escape through six inches of it.

Some of the studies made during the past two years in southern Indiana which have a bearing on codling moth control are herein reported.

CHEMICALLY TREATED BANDS

In a series of tests in 1928 with 135 beta-naphthol treated bands, 862 larvae were captured, only three per cent of which completed their life cycle and emerged as moths. It was found, however, that the beta-naphthol bands captured in some of the tests only 80 per cent as many larvae as similar but untreated banding materials indicating that some repellent action was present.

[1]Contribution from the Department of Entomology, Purdue University Agricultural Experiment Station.

Alpha-naphthylamine (Techn.) was the only one of a large number of chemicals tested in 1928 which showed an effectiveness comparable with beta-naphthol. Both solutions were made up in the same proportions, i.e. one pound of the chemical to one and one-half pints red engine[2] oil. In these preliminary tests with alpha-naphthylamine only six trees were banded throughout the season and no conclusions were drawn. However, the results secured indicated that it might prove equal or possibly superior to beta-naphthol and should be thoroughly tested on a large scale another season.

No evident injury had occurred from the use of either of the chemicals when the bands were removed in October, 1928, though on solid bands both chemicals caused a greater discoloration of the bark than where single faced corrugated strawboard was used. The latter material was found to be the best for chemical treatment because it was most attractive to the larvae and because it provides for better ventilation, thus lessening the chances for injury to the tree.

Relative Attractiveness of Bands

Behaviour studies, in which the reactions of several hundred mature larvae toward untreated and chemically treated bands were observed, produced some interesting results.

In the studies with corrugated paper bands, both treated and untreated, the behavior of each larva was recorded. Healthy hibernating larvae that had been removed from untreated bands in the field tests were used. Each of two unbearing trees with trunks of the same size and shape were banded with three bands, four inches wide, spaced six inches apart. These bands were of materials to be compared and their position with relation to each other was different on each tree and was altered in each successive test. The chemical bands were treated early in July and were allowed to weather a month before the tests were begun. In most instances, 25 larvae were liberated at the base of each tree and observed during each test. The various tests were duplicated on different days during August and September. Separate but similar tests were made with untreated bands of different materials.

[2]Solar red—Standard Oil Company (Indiana). Viscosity—250 seconds at 100°F. Flash point—410°F.

summary of all the tests is given in Table 1.

TABLE 1. RELATIVE ATTRACTIVENESS OF TREATED AND UNTREATED BANDS

	Number Larvae	Number Entrances	Number Exits	Percentage Remaining
Beta-Napthol—Corrugated strawboard	100	148	77	71.0
Alpha-Naphthylamine—Corrugated strawboard	95	148	80	71.5
Untreated Corrugated strawboard	125	138	37	80.8
Burlap and kraft-paper combination	101			67.3
Crepe paper (2-ply)	52			44.2
Tar roofing paper (thin)	70			12.8

Note: All larvae used were mature and all bands were observed for 30 minutes after the last larva disappeared. The above records represent the larvae remaining in the bands at the end of that period. By number of larvae is meant the number of different larvae that reached the band, entered, or passed over it.

The worms which spun up in the chemical bands were allowed to remain. When these bands were removed four weeks after the last test, 68.6 per cent of the larvae in the beta-naphthol and 90.4 per cent in the alpha-naphthylamine bands were dead.

Some larvae entered and left treated bands as many as five or six times while no larva was seen to leave an untreated band more than once. This indicates that contact with the chemical probably irritates the larva and drives it out.

TABLE 2. SUMMARY OF TWO YEARS TESTS WITH UNTREATED BANDS

Banding Materials	Average No. Worms per Band 1927 Orchard No. 1	1928 Orchard No. 2	1928 Orchard No. 3
Corrugated strawboard (double face)	24.2		
Corrugated strawboard (single face)	25.0	3.73	45.8
Burlap-kraft paper combination	19.9	3.10	50.7
Burlap (9 ounce—doubled)	18.1	2.48	31.0
Crepe paper (heavy—2 ply)	15.5	2.08	
Crepe paper (light—3 inch wide)	10.9		
Tar roofing paper	12.5	1.80	35.6

Note: All bands except the light crepe paper were four inches wide. In the 1927 tests conducted in orchard No. 1, ten bands of each material were used except tar paper of which there were 30 bands. In the 1928 tests in orchard No. 2 there were 75 corrugated strawboard bands and 50 each of the other materials. In orchard No. 3 there were ten crepe and ten tar paper bands and 20 each of the other materials. The different type bands in each orchard were well mixed, no two adjacent trees containing the same banding material. The results within each orchard are therefore comparable.

The less light a band admits the greater will be the number of larvae that remain, once they crawl under it. In these tests however, the difference in the amount of light admitted by the various materials was very small. Thickness of the band was found to be the most important factor which caused the larvae to stop and explore and evidently accounted for the large number of larvae which subsequently spun up under the thicker bands. Most of the worms passed over the thinner materials without discovering them. The presence of other bands on the tree, of course, affected the percentage of larvae retained by any one band but indications of the relative attractiveness of the various bands was nevertheless secured and the results agreed with those of 1927 and 1928 field tests.

In the field tests as well as the behavior studies, single faced corrugated strawboard proved most attractive to larvae. This type of band must be replaced at every examination unless it is chemically treated and hence the second best material, a burlap and kraft paper combination which is held together by a tar binder, was found most practical. Thickness is probably the reason why burlap ranked above crepe and tar paper even though the two latter materials shut out more light.

Bands of various widths were tested but those four inches wide proved best. Wider bands do not fit trees with unsymmetrical trunks as snugly while with narrower bands the light which penetrates under either edge reaches too large a proportion of the area covered by the band and hence reduces its attractiveness to larvae.

How Mature Larvae Find the Tree

Mature larvae are able to find the tree by a sense akin to sight. This was well illustrated by studying individually the reactions of about 75 mature larvae liberated at various distances from the base of a tree in daylight and darkness.

Larvae liberated between trees usually traveled away from the light for a distance of several yards and then turned toward the nearest tree traveling at right angles to or directly toward the sun's rays. Once definitely started toward the trunk they usually continued to it.

Approximately 75 per cent of the healthy active larvae liberated in daylight under the overhanging branches on all sides of the tree found the trunk within an hour, and some within five minutes, after their release.

On a cloudless night with no moon, ten active larvae were liberated and observed occasionally by the use of a flashlight. Only one larvae had found the trunk at the end of two hours observation. Several passed

within six inches of the trunk on different occasions but never found it. The discovery of the trunk by one seems entirely accidental for all the larvae were aimless in their movements and crawled about in all directions.

All vegetation had been removed and the surface of the soil smoothed so as to eliminate hiding places and speed up larval activity. Under these conditions it is realized that their reactions probably were not entirely normal and the larvae perhaps over-stimulated in the daylight tests. Subsequent tests proved that the larvae were attracted to any upright object and that odor apparently played no part in their finding the trunk.

Mature larvae are negatively phototropic and observations in the field showed that upon leaving fallen apples in bright daylight most of them crawled into curled-up leaves or similar debris, later, when the light intensity was less, leaving and moving to the trunk or to more substantial cocooning quarters on the ground if these were encountered.

Efficiency of Bands Where Light Surface Debris is Present

Careful examinations were made under two scraped and banded trees late in 1927 in order to determine the proportion of larvae that cocoon in places other than on the tree. One of these, a Genet, had received no sprays for three years. Nearly all the leaves had fallen by the middle of September so a large proportion of the larvae had to crawl over them to reach the trunk. The tree was banded in July with two corrugated paper bands between which was a band of tanglefoot, the latter acting as a barrier, thus keeping separate the larvae which crawled down the tree and those which crawled to it over the ground. During the season, 436 worms were taken from the bands, 219 of them from the lower one.

In October, two sectors comprising one-fourth the area, or about 80 square feet, under the tree were minutely examined for cocoons and larvae. Soil was included to a depth of two inches. Approximately one-fourth or 55 of the larvae under the lower band crawled over this area which contained leaves, clumps of timothy sod, short grass, small weeds, an elm seedling, and three shrubs, (*Symphoricarpos symphoricarpos*). Fallen apples were removed but not examined.

Larvae and cocoons found in the various types of cocooning quarters were as follows:

1. Leaves—three larvae: one dead, none with cocoon started. All apparently hiding while on way to trunk.

2. Shrubs and elm seedling: five cocoons with two hibernating larvae, one dead larvae, one pupa case, one empty.

3. Protruding root of tree: two cocoons, with one hibernating larvae, one pupa case.

4. Wad of paper: one cocoon with pupa case.

5. Sod: one cocoon between two timothy culms with dead larva.

6. Soil: one dead larva, one half-inch below surface.

Disregarding the effect of predacious insects and birds, we can estimate that about 20 per cent of the larvae coming in contact with the ground failed to reach the band. None of them survived in soil or sod and none had spun cocoons in leaves. The shrubs, protruding root of tree, and paper were the important cocooning quarters for the larvae.

Buck brush (*Symphoricarpos symphoricarpos*) is common in most orchards observed in southern Indiana and further examinations showed that many larvae were successfully hibernating on it. On single plants as many as four hibernating larvae were found spun up around the crown and in angles of the roots immediately above the soil.

A Rome Beauty tree in another orchard was used for the second examination. The ground under it was covered with two to six inches of finely pulverized wood, some coarse bits of wood, leaves, weeds, and hollow weed stems. A tar paper band on this tree captured 62 larvae during the season. In one-fourth of the debris about this tree six cocoons were found in the following positions:

1. Small chunks of wood—one empty cocoon.

2. Dead bits of weed stems—five cocoons, with one hibernating larvae, one dead pupa, one pupa case, and two empty.

This band was probably slightly less than 60 per cent efficient. Both examinations indicate that soil, sod, and leaves are generally unattractive to larvae as cocooning quarters if shelter can be found on the trunk.

Other examinations made in 1927 and 1928 show that to be sanitary an orchard must be kept free of artificial rubbish, corn stalks, bits of wood, large weeds, shrubs, mummied fruit, etc.; also, all loose bark, rotting pruning stubs, dead limbs, and broken branches, should be removed from the trees.

The importance of such debris cannot be overemphasized. For example, from one handful or about 20 joint lengths of corn stalks collected by a grower at random from under a Grimes tree in the spring of 1927 and placed in an emergence cage, 662 moths emerged.

Ability to Hibernate in Soil and Light Debris

In order to determine this point 100 larvae removed from bands in October 1927, were forced to spin up in each of four plots containing a bare clay loam soil, leaves, straw mulch, and timothy sod, respectively.

A tanglefoot barrier along the base of the boards inclosing the plots prevented the escape of larvae. Those spinning up in the soil at the base of the boards were removed and more larvae added until a full 100 had spun cocoons within each plot.

These plots were located along the north side of a tree in the orchard. They were covered with wire screen during the period of spring-brood emergence in 1928 and the moths that emerged were removed daily.

Only two moths emerged from pupae in the soil: in leaves 60 per cent survived; in straw 38 per cent; in sod only six per cent. It is interesting to note that emergence reached its peak under these conditions a week earlier than that of emergence cage material. In the straw mulch plot all cocoons found during the examination at the end of the test were in a few leaves that had become mixed in with the mulch.

Though the tests show that larvae can successfully hibernate in leaves the examinations made under the Genet tree in particular prove that they will not do so if adequate cocooning quarters such as bands are available on the trunk. If bands had not been applied to the Genet, it is evident that many larvae would have been forced to cocoon in leaves or sod.

Survival of Larvae in Buried Apples

The 1927 apple crop in parts of southern Indiana was greatly reduced by late frost and many growers picked and buried the apples from trees which had too little fruit to make spraying practical.

Several tests were made in order to determine the depth at which the apples should be buried to prevent the escape of larvae. It was found that larvae could make their way to the surface for two weeks after burial when the covering of soil was not over four inches. During the first week after burial, they could escape through six inches of soil, but later when soil became more solidly packed none were able to escape. A foot of dirt effectively prevented the escape of any larvae.

Examinations were made in various pits at intervals of two to three weeks and mature live larvae found at every examination including the last which was made seven weeks after the wormy apples were buried.

In order to safely dispose of wormy apples by burial they should be covered to a depth of one foot by well packed soil. The place should be observed occasionally and any cracks that might develop as the surface settles should be filled.

A DETERMINATION OF THE LETHAL DOSAGE OF ARSENIC FOR MISSOURI AND COLORADO CODLING MOTH LARVAE

By LEONARD HASEMAN and VIRGIL F. BURK

From experiments conducted at the Virginia Agricultural Experiment Station last year it would seem that apple worms from Colorado were more resistant to arsenical sprays than were worms native to Virginia. In these experiments, however, the ability of the worms to enter sprayed apples was taken as the measure of their resistance to arsenic and no careful feeding experiments were undertaken.

To determine the comparative susceptibility of native Missouri and Colorado codling moth larvae to arsenic a careful feeding experiment was undertaken by the department of entomology. Professor George A. List of the department of entomology, Colorado Agricultural College sent two bushels of wormy apples from Western Colorado for the experiment. The worms were taken from the apples and grouped into classes according to size. Similar classes of native worms were selected from home grown apples and treated in the same way.

A series of seven solutions were prepared from a 100% normal stock solution of pure arsenious oxide. These solutions were prepared so that one drop contained a known amount of As_2O_3 as follows:

(1) .000095 gm: (2) .00026 gm; (3) .00038 gm; (4) .000475 gm; (5) .00058 gm; (6) .000665 gm; (7) .00078 gm.

In order to be sure that each worm in the test ate a known amount of arsenic, dents, about the size of a pea, were made under small slices cut on the sides of apples in each of which was placed one drop of the solution of known strength. A worm which had been previously weighed, was then inserted in the dent and the slice of apple pinned down. This has proven to be a very effective method of feeding the worms measured quantities of arsenic. The worms find themselves in a dark cavity and set to work feeding and soon eat out a considerable cavity surrounding the original dent containing the poison.

Some worms were given large dosages to begin with while others had the dosage increased gradually. Each morning the worms were removed and examined.

Results obtained were as follows:

No. of Worms	Date	Worms	Dosage	Weight	Alive	Dead	% Dead
10	9–15–28	Colo.	.00078 gms.	.0123 gms.	0	10	100
10	9–15–28	Mo.	.00078 gms.	.0275 gms.	4	6	60
10	0–19–28	Colo.	.00038 gms.	.0129 gms.	6	4	40
10	0–19–28	Mo.	.00038 gms.	.0121 gms.	8	2	20
10	9–20–28	Colo.	.00058 gms.	.0217 gms.	4	6	60
10	9–20–28	Mo.	.00058 gms.	.0254 gms.	6	4	40
10	9–21–28	Colo.	.00058 gms.	.0213 gms.	2	8	80
10	9–21–28	Mo.	.00058 gms.	.0253 gms.	2	8	80

From these limited tests it seems evident that the Colorado codling moth larvae have not developed a resistance to arsenic greater than that of native Missouri worms under the same conditions. If there is any difference it seems to be in favor of the Missouri worms.

CITRUS CANKER ERADICATION

By K. F. KELLERMAN, *Washington, D. C.*

The effectiveness of the campaign for the eradication of citrus canker, which was begun in 1915 by this Bureau in cooperation with the agricultural officials of the Gulf States, has been demonstrated in the rapid reduction of infected trees and the thorough going success in preventing epidemics in commercial regions.

No trace of canker has been found in Mississippi since 1922 although it has been found at various times on 130 properties in the State. It is now believed that Mississippi is free from canker but an inspection force will be maintained in that State for several years to prevent a recurrence of an epidemic.

With the exception of one infected tree found in June, 1927, in a nursery at Coden, Alabama, has been free from this disease since 1923.

Florida reported a very serious infection in November, 1927, when 85 trees on two properties were found infected and it was necessary to destroy approximately 200 grove trees adjacent to the infected trees. These two properties were within the city boundaries of Fort Lauderdale and most of the trees were about 15 years old.

This was the first serious outbreak in Florida since 1922 when in September of that year 22 properties at Davie were found infected and it was necessary to destroy 884 grove trees, although in March, 1925, five infected trees were discovered at Boynton and later, in December, 1926, two infections were reported from Sebring.

Of the 515 properties in Florida showing canker at various times, two properties (at Fort Lauderdale) are now classed as "infectious."

There are a considerable number of dooryard plantings in Louisiana with many scattered infections among them but each year the number of infections is reduced and it is believed that it will take at least three years before the disease is completely eradicated from that State.

Canker has been found in nine counties in Texas at various times but during the past few years major efforts were devoted to Brazoria and Harris Counties where many infected trees of long standing were cut back, completely defoliated and sprayed regularly with the result that the trees are now clean and in good condition. So far as is known there is no canker infestation in Texas at the present time but the situation there requires systematic inspection for at least two years.

HYDRATED LIME IN SUMMER SPRAYS FOR THE CONTROL OF THE ORIENTAL FRUIT MOTH

A Preliminary Report

By L. A. STEARNS and R. B. NEISWANDER

ABSTRACT

The results of laboratory tests and orchard spraying experiments conducted in Ohio during 1928 indicate that heavy applications of hydrated lime either alone or in combination with insecticides offer promise as a control for the Oriental Fruit Moth (*Laspeyresia molesta* Busck). Such sprays act as a physical and mechanical hindrance to oviposition, hatching and larval entry. In one orchard, the main crop variety, Elberta, was harvested with 91 per cent marketable and 85 per cent absolutely clean fruit, a reduction of 47 per cent in injured fruit and a decrease of 76 per cent in infestation in favor of the experimental treatment.

The larva is the only injurious stage in the life cycle of the Oriental Fruit Moth (*Laspeyresia molesta* Busck). The frequent repetition of the life cycle each season and the ability of the larvae to feed during the spring and early summer within the twigs and during mid and late summer within the fruits of most orchard trees account in a large measure for the tremendous yearly increase in the population of this insect and for its unparalleled destructiveness as a fruit pest. The prevention or reduction of larval entry into twigs or fruit is, therefore, the control objective.

Hydrated lime has previously been included by Stearns—1920[1], Peterson—1920[2] and Eyer—1927[3] in testing the toxicity of various insecticides for this insect. In no case, however, was importance attached to the results.

The eggs of the Oriental Fruit Moth are commonly deposited on the under surface of the terminal growth of the peach and the just-hatched larvae are forced to crawl for a considerable distance over the plant surface before reaching the favored points of entry, the tip of the twig or the stem end of the fruit. Stearns—1927[4], commenting on further

[1]Stearns, Louis A. Experiments on the Control of the Oriental Fruit Moth. Qtrly. Bul. Va. State Crop Pest Comm., Blacksburg, 2:1, April, 1920, 16 pp.

[2]Peterson, Alvah. Some Studies on the Effect of Arsenical and Other Insecticides on the Larvae of the Oriental Peach Moth. Jour. Eco. Ent. 13:4, October, 1920, pp. 391–398.

[3]Eyer, J. R. Tests of Some Recently Developed Insecticides in Control of the Grape Leafhopper and Oriental Fruit Moth. Jour. Eco. Ent. 20:2, April, 1927, pp. 253–260.

[4]Stearns, Louis A. Oriental Peach Moth Investigation in 1925 and 1926. A Summarized Report. N. J. Agr. Exp. Sta., New Brunswick, Circ. 208, October, 1927, 15 pp.

studies conducted during 1926, recognized for the first time that the results with hydrated lime applied heavily either as a dust or spray on the foliage were significant as indicative of the possibilities of this and other similar materials as physical and mechanical hindrances to entry.

Further observations on the effectiveness of this material in 1927 substantiated this belief. Four treatments of hydrated lime (40 lbs. to 50 gals.) applied at weekly intervals from July 7 to August 4 on four-year-old peach trees without fruit, which had averaged 206 injured twigs per tree by the larvae of the first and second broods, reduced twig injury by the third brood 81%.

During 1928, hydrated lime alone and in combination with insecticides was included in practically all laboratory tests and orchard spraying experiments for the control of the Oriental Fruit Moth in Ohio.

Inasmuch as the insecticidal phase of the investigation was to be emphasized in the future, special consideration was given the development and perfecting of laboratory technique. All sprays were applied with a standard Friend sprayer, at 300 pounds pressure, from a distance of six feet and for a period of eight seconds. Approximately 17,000 eggs and larvae were employed in the tests, the material being retained for observation under controlled conditions of humidity and temperature for a period of about ten days following treatment.

It was discovered that moths display a pronounced indisposition to oviposit on foliage sprayed heavily with hydrated lime. In a varied series of repellency tests, an average of 48 per cent and a maximum of 84 per cent less eggs were deposited on foliage sprayed with hydrated lime (25 lbs. to 50 gals.) than on unsprayed foliage.

In the case of eggs deposited on foliage subsequently sprayed with hydrated lime (15 lbs. to 50 gals.), failure to hatch was due in part to the desiccating quality of the material and in part to the fact that the thickness of the spray covering prevented just-hatching larvae from breaking away from the egg shell. In addition (hydrated lime, 25 lbs. to 50 gals.) the continual cracking and scaling off of the spray covering was found to remove as high as 28 per cent of the eggs as compared with but 2.5 per cent that became detached before hatching under normal conditions.

In tests, in which hydrated lime (15 lbs. to 50 gals.) was combined with insecticides, an average of 71 per cent more eggs became detached before hatching than in other tests in which the same insecticides were employed alone. When added to summer oils (2% strength), the increases in ovicidal efficiency recorded are partly due to this action. With

1.—Appearance of Foliage and Fruit, June 15, 1928

2.—Appearance of Foliage and Fruit, August 7, 1928

such a combination, as high as 94 per cent of eggs failed to hatch with a succeeding kill of 18.5 per cent of the larvae that did hatch. In the case of 40 per cent nicotine (1–800 dilution) and hydrated lime, on the contrary, the rapid freeing of the nicotine resulting from such a combination more than counteracted this action.

The effectiveness of hydrated lime as a larvicide can be attributed partly to its desiccating quality and partly to the impeding of larval movement over the plant surface. Just-hatched larvae in particular become entangled immediately in the fine lime particles and in struggling to free themselves soon succumb.

Approximately 90 per cent of the mid and late summer larvae enter peaches thru the stem end. This type of injury, commonly referred to as "non-visible," since there is no external evidence that the fruit is infested, is highly variable. With Elberta, it averaged 22 per cent in Ohio during 1928. Any amount of such injury is especially undesirable, since the infested peaches are packed as first-grade fruit and reach the critical consumer in a deplorable condition. The larvicidal efficiency of hydrated lime was emphasized by the fact that 69.5 per cent less peaches were injured thru the stem end when the cavity was filled by such a spray (20 lbs. to 50 gals.).

In a peach orchard without fruit, composed of trees three-years-old and younger and divided into square blocks of approximately 48 trees each, an attempt was made to reduce twig infestation. The applications were given with the same sprayer and at the same pressure as in the laboratory tests. Treatments of hydrated lime (25 lbs. to 50 gals.) alone, applied weekly on diagonally duplicate blocks reduced twig injury for the entire season exactly 53 per cent in each instance. Treatments of hydrated lime (15 lbs. to 50 gals.) in combination with other materials and applied every two weeks thruout the season showed an approximately equal, and in some instances a greater efficiency. When added to hydrated lime and applied as indicated, tobacco fish oil soap (10 lbs. to 50 gals.) reduced twig injury 58 per cent; rosin fish oil soap (3 lbs. to 50 gals.), 65.5 per cent; Volck (2% strength), 63 per cent; and Volck (2% strength) and 40 per cent nicotine (1–800 dilution), 77 per cent.

In a five-year old peach orchard with a crop and under normal conditions of rainfall (the excess for the months of July, August and September being but 1.13 inches), six applications were given at approximately ten-day intervals from May 1 to June 27 (40 per cent nicotine at the 1–800 dilution in all but the fifth application and hydrated lime at varying rates as necessitated but averaging 80 lbs. to 200 gals. in all but the sixth application).

The results of the laboratory tests indicate that the nicotine was a somewhat negligible factor in this experiment.

First and second brood larval injury averaged but .9 and 12.6 twigs per tree, a reduction of 75 per cent as compared with the remainder of the orchard which had been sprayed in accordance with the Ohio schedule. Many of the injured twigs had been tunneled to a depth of but one-fourth of an inch; no larvae could possibly have matured in them.

Elberta was harvested 91 per cent marketable clean fruit with but 49 per cent in the remainder of the orchard. The contrasting percentages of absolutely clean fruit in the case of this variety were 85 and 38, respectively, a reduction of 47 per cent in injured fruit and a decrease of 76 per cent in infestation in favor of the experimental treatment.

Alton was harvested earlier with 100 per cent marketable and 98 per cent absolutely clean fruit and the late season variety, Krummel's October (with two additional hydrated lime applications on July 7 and 14) with 79 and 46 per cent, respectively.

The records of fruit infestation indicate that as long as the foliage and fruit were heavily coated with hydrated lime spray the infestation was abnormally light. When the treatments were of necessity discontinued and the spray coating commenced to wear away, the infestation increased proportionately.

THE BUD MOTH IN WESTERN NEW YORK

By S. W. Harman

Abstract

The eye-spotted bud moth, *Spilonota ocellana* Schiff., has appeared in western New York as a major apple pest. In 1928 trees were defoliated early in the season and over 50 per cent of the fruit injured in a number of instances. Summer spraying reduced the injury but left an excess of arsenical residue on the fruit. Moths were killed with nicotine dust, and caught in bait and light traps. Parasites were not important.

The eye-spotted bud moth, *Spilonota ocellana* Schiff., has for many years been a pest of minor importance in the apple orchards of western New York. During 1927 there was some intimation that it was more abundant than usual, and in 1928 the insect appeared in unusually destructive numbers, causing severe injury to the apple crop in certain large plantings.

Serious attention was not given to the insect until June, and for that reason this paper considers principally the midsummer activities of the pest and results of experiments with various materials against the summer brood of caterpillars.

The reason for this great increase in numbers of the bud moth has not been determined. According to reports the insect is more prominent than usual in other areas, and perhaps later events will show that we have entered a period when the pest will demand more consideration than has been devoted to it in recent years. There is also a possibility that on account of the spray program of growers in certain districts there have been left loop holes of which the bud moth has taken advantage. A survey of a number of heavily infested plantings disclosed the fact that dust has been used in many instances to replace former spray practices, and lead arsenate and nicotine have been at times omitted in early season applications. These practices on the part of growers may not fully account for the present activities of the pest, but in the writer's opinion they are an important consideration.

The partially grown larvae issued from their winter quarters in such numbers this past spring that orchards in a number of cases were defoliated and the apple crop materially reduced as a result of the destruction of blossoms and injury to the newly set fruit. The more vigorous and thrifty orchards soon outgrew the foliage injury, but the weaker plantings were slower to recover and showed evidences of the attack for the remainder of the season.

Moths were present in the orchards from late June to the middle of August. As many as ten eggs were found upon single leaves, and it required some effort to find a leaf that did not support at least one egg. During the peak of the flight some 1420 moths were dislodged from one tree by an application of nicotine dust, and considering that newly emerging individuals were constantly replacing the older moths for a period of several weeks, some idea can be had of the enormous numbers of these insects.

The egg hatching period covered from the middle of July to September. At the latter date it was rare to find uninjured foliage, there being from one to several larvae on each leaf. Those apples that had survived the early season onslaught were also attacked, and less than half the picked specimens came thru unscarred.

The injury to the fruit from the early season feeding of the overwintering caterpillars appears as deeply calloused scars somewhat similar to those produced by the fruit tree leaf roller, while the late summer injury by the young larvae is a group of small, shallow feeding punctures. In one orchard under observation 20 per cent of the fruit showed the early injury and 35 per cent the late summer type.

In applying summer sprays special effort was made to cover the lower leaf surfaces to poison the young larvae. The peak of the hatch was

about August first, and an additional application was made at that time. Extra thoro spraying with lead arsenate was practised and the late summer injury was reduced from 35 to 7 per cent. Needless to say, these heavy, late sprays left excess arsencial residue on the fruit at picking time.

The main difficulty encountered in spraying was to coat the lower leaf surface thoroly. The natural pubescence has a tendency to hold the liquid away from the body of the leaf as well as aiding in a quick run-off, thereby preventing the desired coating. This condition, coupled with the fact that the larvae feed beneath the pubescence and under the protection of a silken shelter, necessitates the highest type of spraying to be effective.

Altho careful summer spraying reduced the injury considerably, evidence indicates that emphasis must be paid to early season treatments.

The young larvae were susceptible to nicotine, and this material appears to be a valuable addition to summer applications. It was noticeable that this susceptibility decreased with the age of the larvae.

Moths were caught by thousands in electric light traps and also with a bait of fermented "Diamalt" solution. Nicotine dust brought down large numbers of the adults but, considering the total population in these heavily infested plantings, these catches in all probability had little material effect.

Altho there are some fifteen parasites recorded for the bud moth in North America, they are to date conspicuous by their absence in this outbreak. *Trichogramma minutum* was the most common species observed.

THERMOTROPISM OF THE MEXICAN COTTON BOLL WEEVIL

By EDGAR F. GROSSMAN, *Assistant Entomologist, Cotton Investigations, Florida Agricultural Experiment Station*

ABSTRACT

A new apparatus for determining the thermotropic reaction of insects is described. The Mexican Cotton Boll Weevil (*Anthonomus grandis* Boh.) showed definite orientation in response to 26°F. at the chilled and 130°F. at the heated end of the apparatus, respectively.

Since a large portion of experimental data relative to the response of organisms to temperature has been limited to aquatic forms, and since data on thermotropism in insects are very scanty, the writer undertook a study of the temperature reactions of the Mexican Cotton Boll Weevil (*Anthonomus grandis* Boh.). This insect, due to its relative slowness of

motion and its disinclination to fly, is well adapted for tropistic studies. An additional advantage is found in the fact that, though easily excited, the weevil can be handled without causing disquietude.

If it be assumed that the term *thermotropism* refers to the orientation of an organism with regard to temperature, then the boll weevil can be said to show thermotropic reactions. The large number of innervated hairs found chiefly on the clubs of the antennae, and those found distributed over the legs of the boll weevil, may be the vehicles of temperature impulses. This statement is made because in all of the following temperature reactions, the weevils were in contact, by means of the tarsi and antennae, with either heated or cooled surfaces. Experiments with the weevil "on the wing" were not conducted.

Three methods of experimentation were followed: the first and second, the more conventional ones, gave rather indefinite results, while the third one, a new method designed especially for the boll weevil, gave definite experimental evidence of thermotropic reactions.

The apparatus employed in the first method consisted of a three foot length of ½ inch glass tubing placed within a slightly shorter tube two inches in diameter. The space between the smaller and larger tubes was filled with water and sealed off with corks in such a manner that the smaller tube, excepting its ends, was surrounded with water. By heating the water at one end of the apparatus and chilling it at the other, a gradation of temperature extending from 48° to 140° F. was obtained in the inner tube. After standardizing light, humidity, air current, gravity and tactile conditions, boll weevils were placed at various distances from the hot and cold ends, respectively. The activity of individuals and groups of weevils, was so irregular that one hardly would be warranted in stating more than that there was a general tendency for weevils to remain quietly where they were placed in any portion of the tube, with an occasional exception of that small portion where the temperature exceeded about 120°F.

The second method also gave indefinite thermotropic reactions. Two adjacent compartments of a low temperature incubator, thermostatically controlled by brine and heating coils, were used in place of the outer water jacket employed in the experiments just described. A glass tube, 15 inches long and 2 inches in dameter, was so placed that one-half of the tube extended through the partitioning wall into one compartment, and the other half into the other compartment. The temperature range of the tube, in one set of experiments, extended from 38° to 60° F. Weevils, introduced into either end or the central part of the tube, remained where they were placed. Very little increased activity was

noted when the temperature was changed to a range of 48° to 80° F., since the majority of weevils remained where they were placed. By setting a light first at one end and then at the other end of the tube, a few weevils were caused to move about. Rarely, however, did a weevil pass from one compartment to the other without being oriented by the use of a light.

These two methods probably failed to show thermotropic reactions because there was no distinct change of temperature in the immediate vicinity of the crawling weevils. On the other hand, reaction to light was marked, but in "successful" phototropic experiments there is either light or there is no light; likewise with geotropic experiments, there is an inclined plane or there is no inclined plane. Reasoning along these lines, the author designed an apparatus which would insure definite and immediate temperature changes to which the weevil could be exposed. The third method, therefore, is described in detail, giving the principles involved in building the apparatus.

The experimental field is a plane, measuring 2¼ inches long by 1 inch wide, and consisting of 16 copper bars ⅛ inch wide and $\frac{1}{16}$ inch thick, with $\frac{1}{64}$ inch insulating space between each two bars. Though of uniform width, the bars vary from 4 to 15 inches in length, each bar being bent somewhat like the letter "U", and having an inch of one end form the experimental plate while an inch of the other end is attached either to a copper plate immediately over a 660 watt heater (the 11 heated bars) or to a copper plate submerged in brine or attached to an object carrier chilled with CO_2 (the 4 chilled bars). This arrangement was adopted since by varying the exposed length of the copper bars one inch, respectively, a gradation of temperature between adjacent bars was obtained in the experimental plate. Another bar, located between the heated and chilled bars, is attached to the experimental plate only, and is, therefore, neither heated nor chilled.

Since the average sized boll weevil measures from $\frac{3}{16}$ to ¼ inch in body length, and since the copper bars measure but ⅛ inch in width, a weevil placed on the plate of copper bars must be in contact with at least two of the bars at one time. According to the amount of heat applied, the temperature change encountered by passing from one bar to an adjacent bar can be made to vary from a fraction of a degree to 20 or more degrees (Fahrenheit). For experimental purposes an average of about 4 degrees difference between adjacent bars was held. The weevil, then, met an abrupt change of 4 degrees temperature each time an adjacent copper bar was encountered.

All of the experiments using this apparatus were conducted in a dark room equipped for photographic work. Consequently, such limiting

factors as light, air currents and varying temperature, from other than controlled sources were eliminated. Great care was also taken to control geotropic influences, by keeping the experimental plane as nearly level as possible. Stereotropic influences likewise were eliminated as far as possible by smoothing over the plane, thereby removing those obstacles which ordinarily stimulate tactile reactions.

A total of 1993 experimental tests were made with 126 individuals, representing three classes of boll weevils: those ready for hibernation; those removed from hibernation; and those captured in a cotton field during the month of August. These tests were conducted with but two variables, temperature and light. The temperature varied from 20 to 160° F. The light variations included four conditions: light at a position in line with and beyond the hot end of the experimental plate; light in line with and beyond the cold end; uniform light; and "no light," namely, a red safety light to which the weevil does not react.

The average temperatures to which the weevils reacted definitely were 130° F. at the hot end and 26° F. at the cold end. The highest temperature which failed to repulse a weevil was 158° F., a condition obtained when a weevil became excited and bolted across the plate towards the light. Other weevils, on reaching 140° F., resorted to flying. The lowest temperature a weevil encountered was 20° F., but as low temperatures have a decided chilling effect which causes inactivity, noticeable repulsion was seldom obtained.

It was interesting to note that the weevil, when not exposed to phototropic stimuli, limited itself to a lesser range of temperature changes than when its orientation was directed by both light and heat. Likewise, when the weevil was exposed to uniform light, the range of temperature repulsion, though greater than when no light was used, was smaller than when lights were used to orient the weevil in specific directions; namely, to the hot and cold ends of the plate, respectively.

Another point of interest was one indicating that the two classes of weevils, namely, those ready for hibernation and those removed from hibernation, appeared to react to lower extremes of temperature than weevils removed from cotton fields during the month of August.

Though the apparatus used above was designed especially for the boll weevil, changes in the dimensions of the experimental plate can be made to accommodate the apparatus for experimenting with many terrestrial organisms. The exact temperature of each copper bar can be obtained by the use of a thermocouple. It was found to be necessary, however, to drill $\frac{1}{64}$ or 1/32 inch holes in the bars for the thermocouple, since surface measurements of bar temperature were found to be variable and inaccurate.

ATTEMPTS TO PROTECT SWEET CORN FROM INFESTATIONS OF THE CORN EAR WORM, *HELIOTHIS OBSOLETA* (FABR.)

By STANLEY B. FREEBORN and FLOYD H. WYMORE, *Associate Entomologist and Research Assistant in Entomology, Univ. of California Agricultural Experiment Station, Davis, California*

ABSTRACT

The writers tabulated the stage of development of approximately 10,000 ears of sweet corn of two varieties at the time of treatment. The results when the ears reached market maturity suggest that extra light sodium fluosilicate (70–75%) and a Japanese pyrethrum extract were the most effective insecticides while ordinary black pepper proved to be a very satisfactory moth repellent. The results with arsenates and various nicotine combinations including the new nicotine caseinate were not impressive. Biological observations support the thesis that the larvae migrate from ear to ear and that the loose silk (which receives the coating of dust or spray) is not eaten by the entering larva. It is assumed that the fluosilicates kill by contact or by producing an irritation that impels a cleaning process on the part of the larva after its progress through the dust laden silk.

The corn ear worm, *Heliothis obsoleta* Fab., on account of the fact that it seriously damages two major crops, cotton and corn, and is a pest of several others, has been rated by many entomologists as one of our most serious insect enemies.

Attempts to control the ravages of the larvae of this insect on sweet corn have met with indifferent success and the suggested measures that one finds in texts and popular bulletins are recommended with little hope of success by most entomologists.

During the past season (1928) the writers attempted to measure the efficacy of a number of chemicals, some of which are widely recommended, others previously untried and one based on what the authors believed to be pure "folk-lore." An attempt was made to avoid as far as possible empirical trials, replacing in their stead a laboratory experiment carried on in the field.

A half-acre plot was divided into two rectangular quarter-acre sections one of which was planted to an early maturing corn, Alameda Sweet, and the other to a later variety, Oregon Evergreen. Thirty-three rows of each variety were planted in their respective quarter-acres. The three outside and the three median rows were designated as controls. The twelve rows on either side of the median controls were each set aside for a different treatment, the order being reversed on each side so that the chemical applied on the row nearest the outer edge of the field on one side was placed on the row nearest the center of the field in the replication. It was hoped by this arrangement to avoid our most serious variable, the factor of "spotty" infestation. This would have

been probably of more serious import had we lacked the extremely heavy infestation that was our lot.

At the time of treatment each individual ear or potential ear was tagged, numbered, and its stage of development tabulated. Seven stages of development were recognized in the tabulation ranging from an ear in full silk to a minute leafy shoot approximately two inches long. In the final recapitulations however it was found to be more practicable to condense these to three stages, (1) "silk," (2) "shoot plus" (well developed ear that shows no silk), and (3) "shoot minus" (any of the developmental stages up to the point where they would be termed "shoot pluses" i.e. from a leafy shoot until the presence of the ear within the husk is pronounced. Approximately 10,000 ears were entered on our records. Ten days after the first treatment, which was applied when 10 per cent of the ears were in full silk, a second application was made to 45 ears in each row to test the efficiency of two applications as contrasted with only one. In the table these appear in the twice treated sections under the stage of development that they were in when first treated.

As fast as the ears matured they were harvested and the date of harvest, the presence of larvae or immunity, and the position of the ears in respect to the husks i.e. whether the ears protruded or were covered were entered in our lists.

The tabulations for the controls were kept for individual ears in the same manner and the average immunity for each stage in the Alameda Sweet was combined with that of the same stage in the Oregon Evergreen to furnish the average immunity to be expected from each stage of the combined varieties treated with the same chemical. The varieties were combined to form a general average when it became apparent that the correlation between the efficiency of the insecticide and the control in each variety was so great that the factor of varietal immunity was precluded.

Of the 10,000 potential ears that were tagged at the time of treatment, 6,665 reached the development of marketable ears and furnish the basis for the following reports. These are divided between 5,552 treated ears and 1,113 ears from the control rows.

The following materials were tested as insecticides or repellents each of which is discussed in turn: plain hydrated lime; lead arsenate diluted 1 to 4 with hydrated lime; calcium arsenate in the same dilution; sodium fluosilicate, extra light; commercial sodium fluosilicate diluted in even parts with hydrated lime; caffeine, 1½ per cent solution

in water; nicotine sulfate 1 to 500 in a .37 per cent solution of aluminum sulfate; nicotine sulfate in a .37 per cent solution of hydrochloric acid; nicotine caseinate 1 to 50; nicotine caseinate 1 to 500; commercial black pepper, and pyrethrum extract.

Table 1 presents a condensed percentage table of the immunity enjoyed by the variously treated rows. The percentages are those of both varieties averaged as no varietal immunity could be detected.

PLAIN HYDRATED LIME: Some deterrent effect on egg deposition is shown by the increased immunity where the unsilked ears were kept thoroughly dusted before and during the silking period.

LEAD ARSENATE: The material was diluted with hydrated lime at the rate of one part to four of lime as is usually recommended. The 81 per cent immunity recorded for the "shoot minus" ears dusted twice is evidently somewhat high; otherwise the ears slightly older or dusted but once would have shared in the immunity. The number of ears involved in obtaining this percentage was smaller than any of the other computations and consequently the correlation between the two varieties was extremely poor; the writers are inclined to regard it as "one of those things" that frequently happen in biological investigations. A percentage in the neighborhood of fifty would be far more in keeping with the expectancy curve.

CALCIUM ARSENATE: The high point here is also in the "shoot minus" dusted twice stage which virtually means that the ear was dust covered from at least a week before silking to time of marketing. The increase of only 6 per cent immunity over its diluent, hydrated lime scarcely justifies its expense.

SODIUM FLUOSILICATE, extra light (70–75%). This proved to be our best general insecticide. Applied at any stage it increased the immunity by a considerable percentage. Some burning (of the husks) was experienced but no damage to the product was noted except possibly in its market attractiveness.

SODIUM FLUOSILICATE, commercial (95+%). Diluted with equal parts of hydrated lime this material reflects the performance of the extra light fluosilicate. Its record is not nearly so impressive however. It is interesting to note that the two fluosilicates are the only materials tried that reached their highest efficiency when applied in the silk stage.

CAFFEINE. In these trials, the pure drug supplied us by the Kellogg Sales Company, Battle Creek, Michigan, was dissolved in a small amount of hot water and then placed in sufficient water to form a 1.5 per cent solution of the drug. In this dilution it sprays easily but soon

dries on the leaves and husks to leave a white crystalline deposit which adheres remarkably well. Applied twice, beginning with the "shoot minus" stage it ranks with the best performance of calcium arsenate and is nearly as effective in this stage as the extra light sodium fluosilicate and probably lead arsenate.

NICOTINE SULFATE WITH ALUMINUM SULFATE. Black Leaf 40 was used in a dilution of 1 to 500 made acid with 3.5 grams of aluminum sulfate to the liter of water for the purpose of making the nicotine alkaloid as stable as possible. Its performance was not impressive.

NICOTINE SULFATE WITH HYDROCHLORIC ACID. In this case Black Leaf 40 was used with hydrochloric acid applied to the diluting water at the rate of 3.5 cc. to the liter of water. The immunity percentages are slightly higher, but it does not appear to be a commercial possibility.

NICOTINE CASEINATE. This patented product, a combination of nicotine alkaloid with casein was supplied by its manufacturers, the Hercules Glue Company of San Francisco. Chemical tests made in the laboratory demonstrated that the alkaloid was given off very slowly and it was hoped that it might be an effective means of using nicotine as a repellent or possibly stomach poison. Two strength were used, 1 to 50 and 1 to 500. They equalled but failed to surpass the acidulated Black Leaf 40 solutions but did show a higher immunity in the younger stages when sprayed but once which substantiates the lasting qualities of the nicotine when so combined.

BLACK PEPPER. During the spring of 1928 the senior author was stationed at Coachella, California, on field work in connection with the *Hippelates* fly project. While there Mr. Ed. Goff of that city reported to him that although they were not bothered by the corn ear worm in the early corn that the late corn was sometimes infested and that the people dusted the developing ears with black pepper. As we had two rows available for experimentation in each variety plot the opportunity was taken to try this suggestion. The results as shown in Table 1 would suggest that the pepper actually acts as a repellent to the ovipositing moth. The variance between the results in all four rows tested with this material which are not shown for lack of space was extremely slight showing that the results are true ones.

PYRETHRUM. The material used was a Japanese extract prepared as a watery suspension and carrying the following Japanese analysis: 4% Resin of Pyrethrum, 6% Oil of Pyrethrum, and 90% inert ingredients. This material was made available to us through the courtesy of S. L. Jones & Co., San Francisco. A dilution of 1 to 500 was used. This

material like black pepper produced its highest results when applied to the young ears but unlike the pepper it proved to be a satisfactory treatment in all stages ranking next to the light fluosilicate even when applied to the ears in silk. When all the different types of treatment are considered it must be ranked next to the light fluosilicate in effectiveness with the notation that unlike its competitor it does not burn or discolor the husks.

Our observations would emphasize the fact that although the corn ear worm spends its larval life above ground it is, after all, a cut worm in which the migratory habit is so impressed that it leaves perfectly satisfactory feeding grounds to venture to other ears during the night. Another observation that helps to explain some of the results is that the larvae do not eat the silk or husks unless their way to the ear is barred. Neither a newly hatched nor a migrating larva is forced to eat the portion of the silk that is coated with the applied chemical to reach the ear. Consequently a stomach poison dusted on the exterior or on the loose silk is ingested only by accident. The fluosilicates are effective apparently when they come in contact with the body either as a true "contact" insecticide or by producing an irritation that impels the cleaning of the body by the larva. The pyrethrum evidently remains as a respiratory toxin over a considerable period of time. It is possible, of course, that these substances may function as repellents to both moths and larvae. Further work is contemplated to answer these questions. In the acidulated nicotines and the nicotine caseinate the alkaloid is evidently given off too slowly and consequently in too minute quantities to be effective against the entering larvae. The effectiveness of the remaining materials of which pepper is an outstanding example and including the nicotines rests largely on their moth-repellent factors.

Corn breeding experiments directed against the corn ear worm have emphasized the importance of breeding an ear with a long husk to protect the corn from infestation. In our tabulations we find that in the 229 ears that protruded from the husks 75 or 32.75 per cent were immune. When it is noted that the immunity rate for all ears in the controls is 32.92 per cent it becomes apparent that the long husked or well-covered ear is no better protected than the protruding ear.

TABLE 1. IMMUNITY TO INFESTATION IN TERMS OF PERCENTAGE

Treatment	All Ears Treated Twice	All Ears Treated Once	"Silk" Treated Twice	"Silk" Treated Once	"Shoot+" Treated Twice	"Shoot+" Treated Once	"Shoot—" Treated Twice	"Shoot—" Treated Once
Lead arsenate and hydrated lime 1–4	45	30	33	40	32	18	*81*	39
Hydrated lime alone	36	28	32	15	*42*	34	41	34
Calcium arsenate and hydrated lime 1–4	38	31	34	28	39	36	47	40
Caffeine	26	31	19	26	6	35	*48*	36
Nicotine sulfate 1–500 in $AlSO_4$	21	26	21	18	*38*	29	16	33
Nicotine sulfate 1–500 in HCl	24	33	21	24	*43*	41	23	40
Nicotine caseinate 1–500	21	29	16	17	21	*38*	28	*38*
Nicotine caseinate 1–50	26	33	17	27	42	*43*	31	42
Sodium fluosilicate extra light	58	51	54	*62*	60	44	50	42
Sodium fluosilicate (commercial) hydrated lime 1–1	36	43	36	*52*	42	40	33	34
Black pepper	38	36	18	27	32	36	*61*	48
Pyrethrum	46	38	42	44	38	28	*60*	44
Controls	33		25		34		39	

OBSERVATIONS ON THE CARROT RUST FLY (*PSILA ROSAE* FAB.) IN MASSACHUSETTS[1]

By W. D. WHITCOMB, *Mass. Agri. Experiment Station, Market Garden Field Station, Waltham, Mass.*

DISTRIBUTION

Of European origin, *Psila rosae* Fab., apparently entered this continent in eastern Canada and became established there about 1885. It appears to thrive in a cold climate and has been found in most of the northern border states from Maine to Michigan, with serious outbreaks occurring in New York at several times. Recently infestations have been reported in Rhode Island, Connecticut and New Jersey for the first time.

In Massachusetts the carrot rust fly was recorded by insect collectors over 20 years ago, but it was not recognized as a pest of economic importance until 1926. Since then it has been found in all but the island counties of the state and has increased so rapidly in the northeastern section that in 1928 several acres of carrot plantings were plowed under because of injury to the crop by this pest.

HOST PLANTS

Carrot is the preferred host and only members of the family Umbelliferae are known to be attacked. The degree of infestation of various hosts in 1928 by second generation larvae was recorded as follows:

	Per cent of Plants having One or More Tunnels
Carrot	90
Parsnip	29
Parsley	24
Early Celery	13

Other plants which showed surface feeding on the roots but were neither commercially injured nor served as breeding quarters were coriander, caraway, late celery (Pascal), fennel, and dill. Wild carrots has been recorded as a host but several examinations of them in the vicinity of Waltham failed to locate an infestation.

TYPE AND LOCATION OF INJURY

Plants are damaged only by the feeding of the larvae and on such crops as carrots and parsnips injury invariably occurs below the surface of the ground. The first feeding causes narrow, rust-colored furrows

[1]Published with the approval of the director of the Massachusetts Agricultural Experiment Station. Contribution No. 94, 1928.

and irregular areas in the outer epidermis, but soon small round tunnels are made through the root. These tunnels tend to proceed horizontally although there is little consistency in this respect. The growing tip is usually more severely injured than the upper parts of the root although second generation maggots attack any part of it. In 25 large mature carrots averaging eight inches in length, selected at random, 56% of the larvae were found four inches or more below the crown. In mature carrots the tunnels seldom penetrate the core. Small carrots may be killed by cutting off the feeding roots and by the entrance of fungous rots. More often, however, the plants are stunted temporarily and develop into bulbous and many-legged carrots when growth is resumed. The foliage of infested carrots is thin often having a red or yellow color which is more pronounced on the older leaves.

When carrots are stored in the fall, many larvae are still immature and continue feeding while the crop is in the storage pits. In light infestations, the presence of the maggots is often unnoticed at harvest and much unexpected damage is found when the roots are removed.

In celery and parsley, the feeding roots are eaten, stunting the plant, and occasionally tunnels are made through the fleshy stems above ground.

Type of Plants Attacked

When young carrots develop tops about two inches high, they attract flies for oviposition. However, the late brood of flies apparently prefers to lay eggs near large well-developed carrots, and is able to distinguish them from the bulbous misshapen roots. Two early plantings which had a heavy first generation infestation developed 95 to 98% misshapen roots but showed only 34% and 48% second generation injury, while two later plantings having little or no first generation infestation and producing large, well shaped roots showed 81% and 83% severe second generation injury. Also, 25 large well shaped carrots contained an average of 7.6 maggots per carrot, while the same number of small deformed roots had an average of 3.6 maggots per carrot. The plants in both lots were large enough to supply food for a much larger number of larvae. Similar conditions were observed in all plantings in the experimental field.

Life History, Seasonal History, and Habits

Hibernation is spent in a puparium in the soil and a collection of 170 in April, 1928, showed 86% of them six inches or less beneath the surface. The first fly emerged May 29 and the last July 10, with 74% of them

appearing between May 30 and June 13. In lantern globes over potted carrots, their average length of life was 4.3 days with a maximum of 11 days. The flies are very active and change direction quickly while flying. Oviposition began about four days after emergence and continued until July 9. Periods of heavy oviposition took place from June 11 to 16, and from June 25 to 30. The most productive females laid 20 to 25 eggs but the average was much lower. The eggs are laid singly or in irregular groups in cracks in the soil, under pebbles, or in crevices in the crown of the plant. The average incubation period for more than 400 eggs was 6.17 days, and large numbers of larvae hatched June 20 and July 3. The newly hatched maggots immediately work down the root, seldom making tunnels until they reach the tip. As they grow they tend to work upward and may make several unconnected tunnels before they complete their feeding. It is characteristic to find partly developed larvae protruding from tunnels when infested carrots are pulled. The average length of the feeding period was 27.55 days, and 52% of the maggots left the carrots to enter the soil between July 14 and 19. The last larvae of the first generation were found August 3. Thirty days are spent in the soil of which three are devoted to prepupal preparations and 27 to pupal transformation.

Flies of the summer brood first emerged in the breeding cages August 7 and continued until September 4 with 75% of them appearing between August 8 and 19. The maximum number of eggs was laid August 21 but in the insectary, oviposition by these flies was much less than by those of the earlier generation. The time required for development corresponded very closely to that by the first generation insects, and larvae were first observed leaving carrots September 15. They entered the soil in large numbers on October 4–5 and 17–19, continuing until October 28.

There are indications that a part of the first generation pupae do not transform until the following spring, but this fact has not been verified.

Control Experiments with Cultural Practices

The attack of the first generation larvae can be avoided by planting about three weeks before the "fly-free date." Planting experiments during the last two years indicate that in eastern Massachusetts the safe date for sowing is about June 10. The results in 1928 are as follows:

Date Seed Sown	Date Carrots Examined	Per cent Carrots Damaged
May 1	July 17	96.4
May 15	July 17	74.8
June 1	July 30	8.4
June 15	July 28	0.0

When grown under asphalt paper mulch 82% of the carrots were free from injury by the first generation of the carrot rust fly, compared to 8% grown without paper. Apparently the odor of the paper acted as a repellent. Incidentally the carrots under paper were twice as large by midsummer. However, the paper did not maintain its protective value during the attack of the second generation.

Although not proven experimentally, late fall plowing and the planting of host crops as far as possible from previous infestations have been observed to lessen the intensity of the injury.

Control Experiments with Insecticides

Preliminary experiments with several insecticides showed promising results with derris compounds, corrosive sublimate, and sodium fluosilicate against the first generation.

In the laboratory, all flies confined with potted carrots which had been dusted with powdered derris root died in less than 24 hours. The insecticide was as effective three days after applying as when fresh, and when diluted one-fourth and one-half with gypsum killed the flies as readily as the pure dust.

In the field the pure powdered derris root gave 87% protection following treatments on June 16, 23, and July 2, with a hand duster. The untreated plat suffered 78% injury. Derris-gypsum dust, Derrisol spray, sodium fluosilicate spray, and corrosive sublimate solution gave 70% or more protection under the same conditions. Similar treatments on August 21 and 29 were not as effective against the late brood of maggots when applied under less favorable conditions.

BANDING FOR CODLING MOTH CONTROL

By W. P. Flint and C. C. Goff, *State Natural History Survey*

Owing to the abundance of codling moth and the difficulty of obtaining a satisfactory control of this insect without using excessive quantities of stomach poisons, banding has been coming into more general use the last four years. This measure, which has for many years been considered of value as a supplementary control for the codling moth, has on the whole, been given very little study and little is known concerning the relative effectiveness of different types of bands. In 1917 a series of tests were run in an orchard in south central Illinois using several types of paper bands in comparison with the folded burlap band which had been considered standard up to that time. The results of these tests indicated

that burlap was very much inferior to a light proof tar paper. Only about one-half as many codling moth larvae were taken under the burlap bands as was the case with the tar paper.

In 1927 a more extensive experiment was carried on in an orchard near Urbana in the east central part of Illinois. Eleven different types of bands were tested in this orchard. These were placed on mature Ben Davis and Willow Twig apple trees. The rows of trees selected were in the center of the orchard to avoid as much as possible the influence of light on certain trees in the experiment. The materials tested were: A burlap-lined light proof paper, a cotton thread faced light proof paper, a plain light proof paper, plain black untreated paper, asphalt tar felt paper, gray insulating paper, tar building paper, light proof crepe paper, a second light proof crepe paper (from a different manufacturer), asphalt felt (tar), and Ruberoid asphalt felt.

The bands were placed on the trees early in June and the worms were removed from under them at four periods during the summer and fall. In all, 19,274 worms were caught under these bands. The following table shows the total numbers taken under each material and the per cent of the entire number taken which was found under each material.

TABLE 1.

Banding Material	No. Larvae Taken	Per cent of Total No. Larvae Taken
Asphalt Felt	3185	16.5
Tar Paper (Barrett Co.)	2856	14.8
Asphalt Felt (Bird & Son)	1865	9.7
Burlap paper (7½ oz.) (Rexford Co.)	1783	9.3
Crepe Paper (Graham Paper Co.)	1573	8.2
Ruberoid Asphalt Felt (Ruberoid Co.)	1483	7.7
Cotton lined (16 x 16 threads to inch) (Rexford Co.)	1380	7.2
Crepe paper (Bay West Co.)	1352	7.0
Insulating fabric (Union Paper Co.)	1341	7.0
Plain black untreated paper (Claremont Paper Co.)	1237	6.4
Plain Light Proof Paper	1219	6.3
Total	19,274	100.0

Judging by these tests the tarred papers were the best of the materials tested as was the case in the tests previously reported. Several tests with somewhat similar materials ran in other states indicated that the tar felt was not as attractive as it had appeared to be in the Illinois tests. For this reason another series of tests were run in the summer of 1928 selecting for these tests those papers which had proved the best in the 1927 tests, and adding to these a corrugated paper which Dr. B. A. Porter of the Federal Bureau of Entomology had found quite attractive, and included also bands made of folded ten ounce burlap.

These tests were run in the same orchard as those of the previous season. Forty bands of each material were placed on 200 trees in this test. One hundred of the trees used were large, mature trees and 100 were trees about 18 years old. The bands were placed on the trees in a regular order so that each sixth band was a replication of the one in the preceding series. In order to avoid any great differences in the number of larvae collected from individual trees, the bands were all changed on August 13th on the old trees. The following changes were made: Tarred felt to burlap-faced, burlap to crepe, burlap faced to corrugated and crepe to burlap. In the younger trees the tar paper was changed to burlap, burlap to burlap faced, burlap faced to tar, corrugated to crepe and crepe to corrugated. The larvae were collected at intervals during the summer. The following table gives the total numbers and the per cent of larvae caught under the bands previous to August 13; the worms caught after this date; the total number for the entire season, and the per cent of the total number caught by each material:

TABLE 2.

Type of Band	Total Coll. Thru Aug. 13	Per cent of Total No. Collected	Total Coll. Aug. 13–Oct. 27	Per cent of Total No. Collected	Collection for Season Total No.	Ave. per Tree	% Total No.
Crepe paper	905	26.5	3807	25.8	4712	117.8	25.9
Burlap faced paper.....	548	16.0	3441	23.3	3989	99.7	22.0
Corrugated Paper....	789	23.1	3006	20.3	3795	94.9	20.8
Tar Felt....	624	18.3	2958	20.0	3582	89.6	19.7
Burlap (10 oz.) doubled...	547	16.2	1565	10.6	2112	52.8	11.6
Total...	3413		14,777		18,190		

The tests this year showed approximately the same number of worms caught as last season, but the standing of the different papers was not the same. Crepe paper showed the highest catch of worms for the entire season and for each period during the season. The burlap faced paper had next to the lowest catch of worms during the first part of the season, and was second highest during the latter part of the season and second in efficiency for the entire season. Corrugated paper gave a better catch during the first part of the season but was not as good during the last part. This paper was third for the entire season. The tarred felt paper did not show as well as in previous years, standing third in the catch of worms for the first part of the season and fourth for the second

part. Practically the same per cent of larvae were caught as were taken under the corrugated paper. Heavy burlap folded bands as has been the case in previous years, were distinctly inferior to light proofed papers.

In both 1927 and 1928 a similar series of tests were run in southern Illinois by Mr. Chandler, but owing to the fact that only very small numbers of larvae were taken, these tests could not be given very much weight.

Judging by the tests carried on thus far it seems evident that a light proof paper, either of tar or tar interlined, or burlap faced, is much superior to burlap for a codling moth banding material. It is also evident because of the great variation in the tests that before any conclusion can be reached as to the best material to be used, a larger number of tests will have to be run under varying conditions. This is clearly indicated by the individual band records in the tests conducted during 1928. One tree of the 200 included in these tests produced only a single larva under the band during the entire season, while another tree yielded 401 larvae.

In both 1927 and 1928 experiments were carried on to test the possibility of treating codling moth bands with some chemical which would kill the larvae taking shelter under the bands. A number of materials were tested in 1928, of which the following were the only ones which gave indications of killing a sufficiently high per cent of larvae to make their use practical under commercial conditions. The per cent of kill and the materials used are shown on the following table:

TABLE 3. KILL OF CODLING MOTH IN TREATED BANDS, 1928

Materials	Date of Banding	Exam. up to August 23 Per cent			Exam. Aug. 23–Oct. 27 Per cent		
		Emerged	Alive	Dead	Emerged	Alive	Dead
Orthotoluidine on crepe paper	Aug. 10	0	20.8	79.2	0	73.7	26.3
Monochlornaphthalene on crepe paper	July 26	1.0	30.6	68.4	0	0	0
Beta Naphthol with Benzene on corrugated paper	June 28	2.8	33.8	63.4	1.8	37.5	60.7
Standard Beta Naphthol on corrugated paper	June 28	31.4	51.7	16.9	2.5	79.7	17.8
Beta Naphthol with Orthodichlorobezene on corrugated paper	June 28	14.2	67.6	18.2	0.7	93.3	6.0
Diamond Paraffine—Boiled fish oil soap emulsion—Sodium fluosilicate	June 28	46.4	53.6	0	1.0	93.7	5.3
Whiz soap on crepe paper	Aug. 10	0	53.4	46.6	0	0	0

From the percent of kill shown in the preceding table, it will be seen that a better kill was secured from Beta Naphthol dissolved in benzene and then added to the lubricating oil, than was the case where the Beta Naphthol was dissolved in the heated oil. Mixtures of one part Monochlornaphthalene in ten parts of lubricating oil and the same amounts of Orthotoluidine gave better kills than any other materials tested here. Where these materials were used on crepe paper bands and the bands allowed to remain on the trees for five months, severe injury resulted, especially with the Monochlornaphthalene. The Beta Naphthol and oil gave some injury but in no case was this severe enough to stunt the tree, or apparently to cause any permanent injury.

It is evident that with any of the bands considerable care must be taken in order to prevent injury to the tree, and that recommendations regarding the use of bands can be made only after a number of trials, probably extending over two or three seasons.

SPRAYING FOR THE CONTROL OF ONION THRIPS IN MASSACHUSETTS

By A. I. Bourne, *Massachusetts Agricultural Experiment Station*

Abstract

This pest (*Thrips tabaci*) causes serious losses annually in commercial plantings of onions. In the Connecticut Valley region of Massachusetts, the situation is aggravated by the widespread practice of growing "seed" onions close to fields of "sets."

Dusts, because of their physical drawbacks and the peculiar nature of the plant and the habits of thrips, have thus far proven ineffective. A combined spray of nicotine sulfate and a soft, pourable, potash fish-oil soap has given satisfactory control.

Repeated sprays at 7- to 8-day intervals are necessary to reach newly-hatched young and migrants from near-by fields.

A power sprayer adapted for field spraying of onions has been developed, which has shown excellent promise.

The onion thrips is an outstanding pest in practically every region where onions are grown on a commercial scale. Investigations on this insect were undertaken at the Massachusetts Agricultural Experiment Station because of the serious economic losses caused by thrips to onion growers in the Connecticut River Valley in recent years.

Influence of Set Onions upon Thrips Infestation

The practice of growing "set" onions for the early market has very largely brought about the present situation. Their rapid development early in the season offers a ready source of food and excellent breeding grounds for the overwintering thrips, allowing them to multiply rapidly.

As "set" onions mature, thrips migrate to the more extensive fields of "seed" onions where they cause serious damage to the tender young plants. Moreover, "seed" onions are often planted alongside fields of "sets", which greatly aggravates the situation, a fact noted by Horsfall and Fenton in Iowa, and by many others who have worked on this pest.

Control Measures for Onion Thrips

On the onion, thrips tend to congregate in the narrow space deep in the axils of the inner leaves, the so-called "chits." Fully 80 to 90 per cent of the thrips on a plant are usually clustered there. This habit presents one of the most baffling problems in thrips control and largely explains the comparative failure thus far of dusts to control this pest. Insecticides applied as a spray, however, have proven more successful.

The peculiar type of leaf and its smooth waxy surface makes the onion a difficult plant to cover thoroughly. Any spray to be effective must possess superior adhesive and spreading qualities as well as a satisfactory killing action on the insects.

In general, the various oil sprays proved very toxic to the thrips. However, they showed a great tendency to form into drops and roll off the leaves, resulting in uneven coverage of the plants. This allowed many insects to be untouched by the spray and so escape.

Nicotine sprays alone did not have the necessary physical qualities to satisfy the above requirements. The addition of soaps improved the adhesive and spreading qualities, and this combined spray has proven very successful.

Commercial 40% nicotine sulfate was the basis of the spray. This was combined with fish-oil soap. The type found best adapted for this purpose was a soft, pourable potash soap. This product had many physical qualities which strongly recommended it for use under field conditions. Its consistency was so uniform that its ratio of weight to fluid measure was very constant. This, and the readiness with which it diluted into the spray solution, constituted two important time-saving elements in its favor.

This combined spray proved to have excellent spreading and flowing qualities, and gave a thorough and uniform coverage of the smooth, waxy surface of the onion plants. Practically all of the run-off flowed down to the base of the leaves. When the spray was applied at 150 to 175 pounds' pressure it readily penetrated the "chits," thus reaching the parts of the plant where thrips would be principally located.

The alkali of the soap also served as an activator of the nicotine. This hastened the killing action of the spray and also allowed a con-

siderable reduction in the amount of nicotine necessary. By the use of 6 to 8 pounds of potash fish-oil soap in 100 gals. of the spray, it was found that, instead of 1:1000, a 1:1200 or 1:1500 dilution of nicotine sulfate proved effective. This allowed a material reduction in the cost of each application.

Spray Schedule for Thrips Control

At the height of the growing season, the rate of reproduction of thrips is high so that reinfestation of the onion plants is very rapid. In our experiments, plants cleared entirely of thrips and screened to prevent reinfestation from outside showed, on an average, 150 to 200 young thrips emerging from eggs embedded in the leaf tissues, in a space of five to six days. In some cases the number was over 500. This accounts for the fact, noted by many observers, that, despite a high percentage of kill by a spray, fields often show a heavy infestation within a few days, which sometimes leads the grower to believe the application has been ineffective.

Such a rapid reinfestation of the plants by young thrips proved that a follow-up spray was practically essential. This should be applied as closely as possible to the time when all the eggs had hatched and before the first larvae to appear had reached maturity and left the plants for the nymph stage. Life history studies showed that in the Connecticut Valley region the duration of the egg stage averaged 5 to 6 days, while the larvae required about 7 days to fully develop.

It would appear, therefore, that the second spray should follow 5 to 6 days after the first. It was discovered, however, that few if any thrips appeared during the first two days after each application of nicotine. The period between sprays, therefore, could be safely extended to 7 or 8 days.

If the attack is very severe, reinfestation either by young newly-hatched larvae or by thrips migrating from neighboring fields may make one or more later sprays necessary. After the first week of August, the plants have usually reached a size and stage of development where they can successfully withstand an ordinary attack, as do "set" onions earlier in the season, so that further spraying is unnecessary.

Field Sprayer for Onions

The onion thrips themselves are readily killed by a contact spray, yet they are so well protected by the plant that successful control is not obtained by ordinary methods and machinery used in applying such sprays.

The great difficulty which has stood in the way of success of the sprays has been the lack of suitable machinery. It is the practice in the Connecticut Valley to plant the onions in rows 12 to 14 inches apart. The ordinary types of horse-drawn sprayers cannot be used under such conditions. The large size of the fields makes the use of any small outfit impracticable. The problem was submitted to several manufacturers of spray machinery. The machine finally developed, which at present most nearly satisfies requirements, is the Spra-Mor, a product of the Held Tractor Co. of Columbus, Ohio. (Plate 20, fig. 1).

This is a small power sprayer. Its power unit is a twin cylinder Indian Scout 3-speed motor, which adapts the outfit to operation on a variety of crops and allows light or heavy applications as desired. The motor serves to propel the machine and operates a 2-stage heavy-duty air compressor, which furnishes the pressure for spraying. The spray tank is of 65-gal. capacity and is equipped with pressure gauge, safety valve, etc.

The whole outfit is carefully balanced on a pair of wide-rimmed wheels 3 feet in diameter. This allows an 18 inch clearance, which has proven to be ample even for late season spraying.

A smaller pair of wheels at the rear serve to steady the machine and aid the operator in driving over rough ground and in turning.

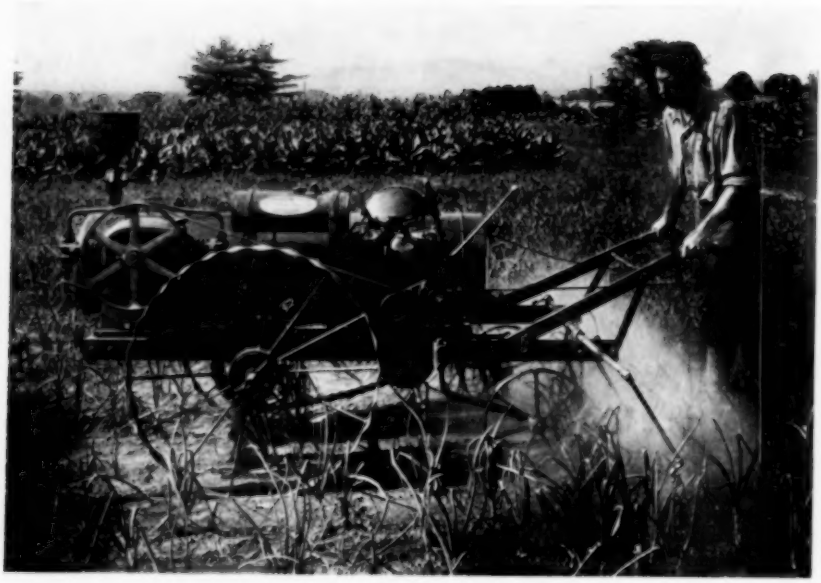
The spray boom is attached to the frame just in front of the operator.

This machine will develop a working pressure of 200 pounds.

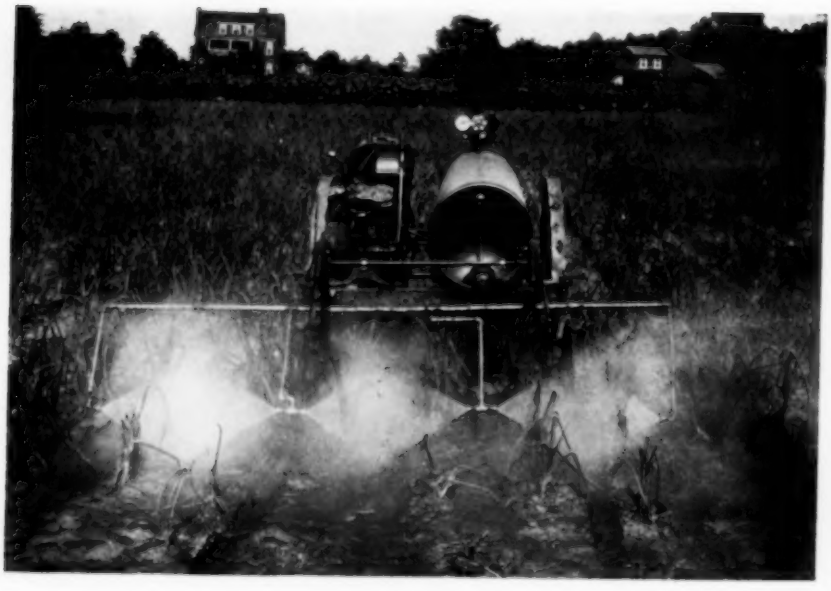
In field tests, spraying onions and celery, it has demonstrated its ability to develop and maintain such a pressure and carry a full tank of spray with the engine at slightly more than idling speed. This pressure has proven more than adequate for satisfactory spraying of onions.

A special spray boom was constructed which would deliver the spray at proper height and distance from the plants to insure penetration of the "chits" and thoroughly cover all parts of the onions. (Plate 20 fig. 2). Disk nozzles, with $\frac{1}{16}$ inch opening, were found to be the most satisfactory type. These broke the spray into a fog-like mist which insured excellent coverage and discharged it at sufficient pressure for satisfactory penetration. With smaller opening disks, a finer mist was secured but the spray lacked suitable pressure.

Experiments showed that for onions a 6-row coverage was best adapted to the machine. This required a boom slightly more than seven feet long. Any material lengthening of the boom was found to so increase the difficulties of operation that thorough spraying was well nigh impossible.



1.—Spraying machine for onion thrips.



2.—Spray boom for onion thrips.

The machine was successfully operated in fields of 13- and 14-inch rows, and repeatedly demonstrated that with careful handling fully 90 to 95% pf the plants sprayed would be thoroughly covered and the thrips upon them killed.

Field tests have shown some minor adjustments to be necessary. This is to be expected of any newly-developed machine, to adapt it to particular needs. The outfit has. however, already demonstrated that it is practicable and has shown excellent promise.

THE ONION MAGGOT SITUATION IN NEW YORK

By HUGH GLASGOW and HAROLD T. COOK

ABSTRACT

Of the various methods that have been suggested for control of the onion maggot (*Hylemyia ceparum*) the lubricating oil bordeaux sprays are at present the most promising, cost, efficiency, and ease of application considered. With the perfection of the small tractor sprayers this method has developed into a thoroly practical and economical means of maggot control. . In addition to their insecticidal properties these sprays have also proven of value in checking the development of weeds in sprayed fields while at the same time causing no serious permanent injury to the crop.

The onion maggot (*Hylemyia ceparum* Meig) is a persistent and troublesome pest in New York where it has long continued to exact its toll from the onion grower. Within comparatively recent years, owing perhaps to the more intensive cultivation of its principal host plant, the ravages of this pest have assumed increasingly serious proportions. This progressive increase in injury has finally reached a point in many of the more important onion growing sections of the state where some practical means of control, adapted to large scale operations, has become imperative if onion growing is to be continued at its present volume.

In the course of the past four seasons various means of control that appeared to be applicable to the conditions under which onions are grown in New York have been tested. Among other methods of control such operations as clean culture, crop rotation, the use of poison baits and sprays, the application of repellents and of various soil insecticides have been given consideration. While a number of these methods have shown distinct merit in checking the losses caused by the maggot, the oil sprays as suggested by Flint and Compton have, on the whole, given more promising results than any of the other methods so far tested. Since the oil sprays have given the greatest promise for practical control —cost, efficiency and ease of application considered—the present discussion will be confined largely to our experiences with these preparaitons when used under New York conditions.

The bulk of the onions produced in New York are grown on muck soils, from seed, and the resulting plants are, therefore, in the field where they are subject to attack by the maggot for a period of from four to five months.

The flies emerging from the overwintering puparia often commence to appear in April and, owing to the overlapping of the various broods, they are present in the field and are depositing eggs thruout most of the growing season.

In the course of our work with oil sprays a large number of commercial as well as home-made preparations have been tested. This list includes both miscible oils and oil emulsions alone and in combination with various insecticides incorporated with the oils previous to their emulsification. In this way various insecticides and repellents, such as naphthalene and paradichlorobenzene may be combined with the oils without interfering with their emulsifying qualities. Such combinations have sometimes appeared to increase the efficiency of the oil sprays somewhat, when applied for maggot control, but the differences observed have not been consistent enough so far to warrant their use. On the other hand, the addition of as much as 10% naphthalene or paradichlorobenzene to the oils has never resulted in any noticeable increase in their toxicity to the plants treated.

It has been possible to secure commercial control of the onion maggot with oils of various grades, but of the different oils used the simple lubricating oil emulsions have generally proved the most satisfactory, all things considered.

The lubricating oil emulsions, whether used alone or in combination with Bordeaux mixture, have been found to give commercial control of the maggot, but the spray that has so far given the most consistently satisfactory control under New York conditions has been a two or three per cent red engine oil emulsion combined with a 4–4–50 bordeaux mixture applied at the rate of approximately 150 gallons per acre. The bordeaux mixture, while not essential, appears to add appreciably to the efficiency of the spray and also serves a useful function in stabilizing weak emulsions, as when the home-made lubricating oil-soap emulsions are used.

Under New York conditions where onions are grown largely on muck soils in narrow rows, the drip method of applying the oil emulsion for maggot control has never been a success. This was due largely to the difficulty of following the row and of securing an even distribution of the liquid, particularly when the surface of the muck was at all dry. This is perhaps the chief reason why the general adoption of oil emulsions for maggot control has been so slow in many of the larger onion growing sections.

Experimental block showing onion maggot control by the use of Bordeaux-oil spray (See text for arrangement of plats and schedule of treatments.) Remainder of field outside experimental blocks sprayed.

With the recent development and perfection of the small tractor spray outfits that are now available, where the emulsion is applied under pressure, this difficulty has been largely overcome. By the use of such machines oil sprays can now be quickly and effectively applied on muck soils and the use of this method of control in large scale operations made feasible. Under field conditions such oil sprays have seldom given us perfect control of the maggot but the protection afforded by even a comparatively few properly-timed applications is so striking, as a rule, that the value of the method is usually apparent even to a casual observer wherever the infestation is severe enough to bring out such contrasts.

The accompanying table will serve to illustrate the effectiveness of the lubricating oil sprays in preventing maggot injury. In this particular case the material used was a two per cent Red Engine Oil emulsion in a 4-4-50 bordeaux mixture applied at the rate of 150 gallons per acre at a pressure of from 20 to 30 pounds. The figures given represent the total number of onions harvested from a 100 foot section of row.

CONTROL OF ONION MAGGOT WITH 2% RED ENGINE OIL-BORDEAUX SPRAY.*

Number of	Week when applications commenced						Check
Applications	1st	2nd	3rd	4th	5th	6th	
1	463	222	349	113	68	163	164
2	731	480	233	181	115		146
3	968	395	204	119			249
4	1013	663	250				83
5	1012	763					65
6	1054						106

*Figures represent total number onions from 100 ft. row.

This table will also serve to illustrate the arrangement of the plats and the schedule of treatments that was adopted as a routine in all of the more important tests that were conducted in the course of our studies on the onion maggot. For each material or concentration to be tested in these studies a uniform block 100 feet long made up of 21 continuous rows was selected. Such a block was then divided into six sections containing six, five, four, three, two, and one rows, respectively. In addition to the 21 treated rows in the main body of the experiment three untreated rows were retained on either side to serve as a check. As far as possible such experiments were always located in a commercial planting where maggot injury had been severe the preceding season. Six applications are provided for in such an experimental block, commencing when the flies begin to appear and deposit eggs in the field and continuing at intervals of approximately one week until all six treatments have been made.

Experimental block showing onion maggot control by the use of Bordeaux-oil spray (See text for arrangement of plats and schedule of treatments.) Remainder of field outside experimental blocks sprayed.

The initial application is made to include all six rows of Section 1, the second includes the last five rows of Section 1 and all five rows of Section 2. The third week of the experiment the last four rows of Section 1, the last four of Section 2, and all four rows of Section 3 are treated. This schedule is followed throughout the course of the experiment, the applications being repeated at intervals of approximately one week until the entire six provided for have been made. By this procedure it will be seen that one entire new section is added each week and one row successively dropped from each of the preceding sections, at each application, until at the end of the six weeks period during which the treatments are made only the last row in each of the six sections receives the final application.

While the procedure outlined above may at first appear somewhat cumbersome and involved, in practice it is not difficult to carry out. On the whole such a scheme has proved extremely satisfactory as adapted to problems of this type. Where intelligently handled an experimental block such as the one described, providing as it does for 21 distinct combinations, should answer most of the questions that can logically be put to such a test bearing on the proper timing of the various applications, the number of treatments necessary to give the desired degree of control, and the relative value of deferred applications.

As may be seen from a comparison of the yields recorded in the table, proper timing in the use of oil sprays is of vital importance to successful maggot control. Where the initial application is deferred for even a week the degree of control is greatly reduced, while little or no benefit results where the treatment is delayed even two or three weeks beyond the optimum period. When properly timed three thoro weekly applications have usually given good commercial control of the onion maggot, altho in some of our tests the benefit resulting from the fourth and fifth applications has been more apparent than in the particular series of tests given above. Beyond the fifth application we have never been able to detect any appreciable benefit resulting from the use of oil sprays.

A study of the accompanying photograph showing one of these test blocks may help the reader in understanding the arrangement of the different plots. From an examination of this photograph and by comparing the yield records given in the table, it should be apparent that in onion maggot control the early applications are the vitally important ones, the protection afforded by the later applications seeming to be of comparatively little importance under normal conditions in the field. Just why such later applications should not be of greater importance in carrying the crop thru the long growing season is not at once apparent

for the insect is generally present and depositing eggs long after the residual effect of the comparatively light early applications must have disappeared from the soil. Apparently under normal conditions the insect is able to establish itself only with great difficulty in sound onions after they have reached a certain stage in their development; at least this seems to apply in the case of the varieties commonly grown in New York. Whether the protection resulting from a few early applications will always carry thru the entire season in the case of extremely tender, thin skinned varieties or during exceptional seasons remains to be seen.

In addition to their insecticidal properties the oil sprays are often extremely valuable to the onion grower as weed killers. In some cases the benefit to the grower from this aspect of the situation equals or even exceeds that resulting from maggot control. In one field test where this feature of the problem was carefully checked it was found that the four early applications made for maggot control practically eliminated many of the more troublesome weeds from the field and reduced the problem of weeding to extremely simple proportions. When is it considered that the operation of weeding, involving as it does a large amount of expensive hand labor, is often one of the heaviest items of expense in onion growing, the weed killing properties of the oil sprays cannot be ignored, and the cost of the treatment cannot justly be charged entirely to maggot control.

The feeling is common among many of our growers that the weed killing feature of the oil sprays will often warrant their use as a routine operation in onion growing, even leaving the question of maggot control out of consideration. Here as in maggot control the importance of the early applications is apparent since weeds are much more susceptible to oil injury when young.

Fortunately, the onion seedling is quite tolerant of oil sprays, for, altho the young plants are often noticeably dwarfed and discolored, particularly after the first applications, actual killing of the main leaves seldom occurs and, as a rule, the plants quickly recover from the initial shock of the treatment.

In some of our tests where maggot injury did not develop there was some indication that five or six applications of an oil spray may have reduced the yield somewhat, but this apparent reduction was so slight that in most cases it can probably be ignored, particularly if the maggot is at all prevalent.

It has been repeatedly observed that onions treated with the bordeaux-oil spray for maggot control keep better in storage than those taken from

unsprayed fields. The natural assumption is that the bordeaux residue on the onions checks the development of storage rots, but the improved keeping qualities of sprayed onions really appears to be due mainly to the elimination of the maggot infested onions, which when placed in storage, soon decay and serve as centers of spoilage.

PYRAUSTA NUBILALIS HUBN. IN EUROPE: NOTES ON INFESTATION AND PARASITISM FROM 1926 TO 1928

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ABSTRACT

This paper is supplementary to Technical Bulletin No. 59 of the U. S. Department of Agriculture, "The European Corn Borer and Its Controlling Factors in Europe", and contains certain data assembled since the preparation of the manuscript of that publication and covering the years 1926, 1927, and 1928. These include records of percentages of infestation by *Pyrausta nubilalis*, additional records of the distribution of parasites of *P. nubilalis;* parasitism by species and zone, for the three years mentioned; new determinations of corn-borer parasites; and records of secondary parasites.

Since the preparation of the manuscript for the recent bulletin by Thompson and Parker[1] on this subject, additional studies have been made and other points of interest brought to light. These will be mentioned briefly here.

As will be noted from Table 1, no striking changes have taken place in the infestation of either corn or Artemisia. In Artemisia, while the average infestation remains about the same in the districts around Paris and Lille, there is a general shifting of the larval population from year to year in the infested region, some fields being heavily infested one year and lightly the next, with all degrees of intermediate infestation. In the areas where parasite studies have been made, no appreciable losses have been observed in corn during this period.

Table 2 shows the parasitism by species and zone for the years 1926 to 1928 so far as the writers have been able to study it. The most remarkable item under this head is the heavy parasitism of the first generation of 1927 in the Po Valley of Italy (Padovian Zone) where there was a total parasitism of 48% based on a study of about 200,000 specimens.

[1]The European Corn Borer and Its Controlling Factors in Europe by W. R. Thompson and H. L. Parker. Tech. Bul. No. 59, U. S. D. A., Washington, D. C., April, 1928.

TABLE 1. PERCENTAGE OF INFESTATION BY *Pyrausta nubilalis* IN EUROPE

Zone	1926			1927			1928		
	Corn Gen. I	Corn Gen. II	Artemisia	Corn Gen. I	Corn Gen. II	Artemisia	Corn Gen. I	Corn Gen. II	Artemisia
Mediterranean (Coast)	23.0	26.0	[1] [2]	6.0	15.0	....	38.0	....	....
Mediterranean (Rhône)	23.0	[3]	[1]	....	....	....	47.0	4.0	....
Central	....	....	....	....	....	20.0	....	....	....
Aquitainian	33.0	[3]	[1] [2]	13.0	....	....	45.0	....	....
Rhodanian	33.0	[3]	5.0	....	....	....	....	....	....
Vosgian	*65.0	....	....	....	....	....	....	....	....
Sequanian (North)	[1] [2]	....	55.0	....	....	55.0	....	....	50.0
Sequanian (South)	[1] [2]	....	20.0	....	....	20.0	....	....	50.0
Armorican	[1] [2]	....	35.0	....	....	35.0	....	....	36.0
Padovian	20.0	39.0	[1]	40.0	....	....	21.0	....	....
Campanian	14.0	9.0	....	23.0	23.0	....	27.0	....	....
Venetian (High)	....	....	....	....	....	....	9.0	....	....
Venetian (Low)	....	....	....	....	....	....	40.0	....	....
Plavisian	....	....	....	....	....	....	19.0	....	....

[1]Plant not infested in this region.

[2]Plant occurs but slightly in this region.

[3]Generation did not occur this year.

*From studies of Zwölfer (Bericht über die Untersuchungen zur Biologie und Bekämpfung des Maiszünslers (*Pyrausta nubilalis* Hübn.) in Süddeutschland 1926 by W. Zwölfer. Arbeiten aus der Biologischen Reichsanstalt für Land- und Forstwritschaft. Band 15, Heft 3. Berlin-Dahlem. Sept., 1927.)

It has been noted that the parasites occurring in any given area are not evenly distributed but are found in what might be termed "pockets." For example, in the Aquitainian Zone (southwestern France), where seven collecting stations are in operation, a certain species will predominate at one point while another will be more abundant at the second, and so on.

Another feature of interest is the finding of *Pyrausta nubilalis* in considerable quantities near Avignon. As pointed out in Technical Bulletin No. 59 of the U. S. Department of Agriculture, practically no borers had been found in the wind-swept district of the lower Rhône Valley from Marseilles to Orange. In the late summer of 1928, however, in a field well sheltered from the wind, an infestation of 80% was located. The parasites present included *Masicera senilis* Meig., *Zenillia roseanae* B & B., and *Microbracon brevicornis* Wesm.

Owing to the excessively warm summer season of 1928 a rather high percentage of first-generation Pyrausta pupated and issued in the "transitional" areas, i.e., those in which the number of generations

TABLE 2. PERCENTAGE OF PARASITISM OF *Pyrausta nubilalis* BY SPECIES AND ZONES IN EUROPE
1926

Species of Parasite	Mediterranean, C.		Mediterranean, R.	Aquitainian	Vosgian	Sequanian, N.	Sequanian, S.	Armorican	Campanian	Padovian		Mediterranean, C.		Aquitainian	Central	Sequanian N.	Sequanian, S.
	CI	CII	C	C	A	A	A	A	C	CI	CII	CI	CII	C	A	A	A
Masicera senilis	10.1	4.0	1.1	0.5	...	...	...	...	18.0	0 7	1.9	4.8	4.1	1.8	1.2	...	...
Zenillia roseanae	0	1.2	0	3.4	...	...	...	...	1.0	0.02	—0.01	0	0.4	0.9	...	...	...
Nemorilla floralis	...	...	...	...	...	...	...	...	...	0	...	...	...	...	...	...	...
Nemorilla maculosa	0	0	...	...	...	...	...	...	—0.01	...	...	0	0	...	...	...	...
Zenillia mitis	...	...	...	...	...	0.2	—0.01	...	...	...	...	...	...	...	...	0.03	—0.01
Eulimneria crassifemur	...	...	0	2.6	0.6	0.3	0.5	0.1	1.0	0.5	—0.01	...	...	2.6	0.9	0.4	0.7
Dioctes punctoria	1.3	0.3	0.3	—0.01	...	...	...	—0.01	1.0	5.9	1.6	20.4	0	0.02	...	...	...
Campoplex lugubrinus	...	...	...	...	...	0.1	0.1	...	...	...	...	...	...	...	...	0.2	0.1
Campoplex rothi	...	...	...	...	...	0.05	...	...	...	...	...	...	...	...	...	0.1	0.02
Microbracon brevicornis	0	0	0	0	...	...	0	0.2	—0.01	0	0	0	0	0	...	...	...
Microgaster tibialis	...	...	...	0.05	2.2	18.0	52.5	0.2	—0.01	3.2	0.1	...	...	0.1	...	13.2	31.3
Apanteles thompsoni	...	...	...	0	...	3.2	...	...	...	...	...	...	...	...	...	6.6	...
Macrocentrus gifuensis	...	...	...	...	...	...	— 0.01	33.3	...	...	...	...	...	...	22.7	...	2.0
Chelonus inanitus	...	...	...	...	...	...	...	...	...	—0.01	0	...	...	...	...	...	...
Hemiptarsenus unguicellus	0	0	...	...	...	...	0	...	0	...	...	0	0	...	...	...	0
Theronia atalantae	0	0	...	...	...	...	...	...	...	0	0	0	0	...	...	...	...
Phaeogenes nigridens	0	0	...	0	...	...	...	...	...	8.1	0	0	0	0	...	...	...
Exeristes roborator	0.7	0	0	0	...	...	0	—0.01	...	...	0	0	0	0	...	...	0
Total	12.1	5.5	1.4	6.6	2.8	21.9	53.1	33.6	21.0	18.4	3.6	25.2	4.5	5.4	24.8	20.5	34.1

Species of Parasite	1927		1928																
	Amorican	Campanian	Padovian		Dalmatian	Mediterranean, C.	Mediterranean, R.	Aquitainian	Sequanian, N.	Sequanian, S.	Armorican	Padovian	Venetian, High	Venetian, Low	Plavisian	Danaprisian, N.	Dalmatian
	A	C	CI	CII	C	CI	C	C	A	A	A	CI	CI	CI	CI	C	C
Masicera senilia	...	32.2	0.2	4.2	...	13.5	7.7	0.7	...	...	...	0.8	11.2	2.6	2.9	8.8	...
Zenillia roseanae	...	0.1	—0.01	0.1	24.0	0	0.2	11.7	...	...	...	0.02	...	...	...	...	30.7
Nemorilla floralis	...	...	0	0	...	...	...	...	...	...	...	0	...	...	...	...	...
Nemorilla maculosa	...	0.1	...	...	...	0	...	...	...	...	...	...	...	...	...	...	...
Zenillia mitis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eulimneria crassifemur	0.4	0.6	0.9	1.0	...	...	0	1.7	0.3	1.8	0.6	1.0	...	...	1.6	1.3	...
Dioctes punctoria	...	0	14.5	0.5	...	1.5	0.2	...	...	...	...	7.2	5.9	13.6	3.7	5.0	...
Campoplex lugubrinus	...	...	...	...	...	...	...	...	0.1	—0.01	...	...	...	...	...	...	...
Campoplex rothi	...	...	...	...	...	...	...	...	0.3	0.2	...	...	...	...	...	...	...
Microbracon brevicornis	...	0	0	...	...	0	0.2	...	...	...	...	—0.01	0.3	0.6	1.0	...	...
Microgaster tibialis	0.1	0	15.0	0.1	...	...	...	0.7	21.5	26.6	0.1	7.3	0.3	...	...	1.3	...
Apanteles thompsoni	...	...	...	...	...	...	...	...	2.5	...	...	...	...	...	...	6.3	...
Macrocentrus gifuensis	36.2	...	...	...	...	...	...	...	...	...	31.5	...	...	...	...	24.0	...
Chelonus inanitus	...	...	0	0	...	...	...	...	...	...	...	—0.01	...	...	3.2	...	...
Hemiptarsenus unguicellus	...	0	...	...	0	...	...	...	...	...	...	...	...	...	...	...	...
Theronia atalantae	...	...	0	0	...	0	...	...	...	...	...	...	...	...	...	...	...
Phaeogenes nigridens	...	...	17.5	0	...	0	...	...	...	...	...	4.3	1.2	1.9	4.6	...	...
Exeristes roborator	...	...	—0.01	0	...	0	0	...	...	...	...	...	...	...	...	...	...
Total	36.7	33.0	48.1	5.9	24.0	15.0	8.3	14.8	24.7	28.6	32.2	20.6	18.9	18.7	17.0	46.7	30.7

0 indicates that the parasite occurs in the region but that none were found in that year study.
A = in Artemisia.
C = in Corn.
I = 1st generation.
II = 2nd generation.
Note: No studies were made on *Trichogramma evanescens*

occurring annually varies according to the character of the season. In the Aquitainian Zone (southwestern France) an average of 5.5% pupated and in the northern part (upper Rhône Valley) of the Mediterranean Zone the percentage of transforming larvae ranged in different fields from 2.5 to 63%, with an average of 32%. In the above noted field near Avignon 35% of the first-generation borers transformed and emerged.

Various other interesting facts have been learned in relation to the distribution of the parasites of *Pyrausta nubilalis* in Europe, among which may be mentioned the following: The presence of *Apanteles thompsoni* Lyle in very limited quantities at Bayonne in the Aquitainian Zone (southwestern France); the occurrence of *Macrocentrus gifuensis* Ashm. in large numbers at St. Etienne in the Central Plateau of France, its presence at Limoges in the same region, and its apparent increase in the Paris district; the existence of *Masicera senilis* at St. Etienne; and the presence of *Microgaster tibialis* Nees at Cazaubon in the Aquitainian Zone (southwestern France) where the parasitism in that limited district amounts to 0.7%.

Dioctes punctoria Rom. was found in small numbers in Artemisia in the Amorican Zone near Tours; in an area around S. Giorgio di Nogaro in the province of Udine, Italy (here called Plavisian Zone), the parasitism by *Chelonus inanitus* L. in the first generation of 1928 was 3.2% with a maximum in one field of over 9%. This is the first time that this latter species has been found in an appreciable quantity.

A total parasitism of 46.7% was discovered in larvae of *Pyrausta nubilalis* collected in the mixed forest and steppe region of the Dnieper River in Russia, henceforth called Danaprisian Zone (North), composed of 8.8% by *Masicera senilis*, 1.3% by *Microgaster tibialis*, 1.3% by *Eulimneria crassifemur* Thoms., 5% by *Dioctes punctoria*, 24% by *Macrocentrus gifuensis* Ashm., and 6.3% by a colonial braconid which is probably *Apanteles thompsoni*. A parasitism of 24% in 1927 and 30.7% in 1928 by *Zenillia roseanae* was revealed by studies in the Dalmatian Zone.[2]

In Technical Bulletin No. 59 an undetermined campoplegine was mentioned as a probable parasite of *Pyrausta nubilalis* in the Lille district. As a matter of fact, two species of this group occur as primary parasites of the borer in both the Lille and Paris districts. These have

[2]This zone is the geographical portion of Yugoslavia commonly known as Dalmatia. It is the narrow coastal strip bounded on the north by Croatia and on the south by Montenegro. On the east it is separated from the Province of Bosnia by the Dinaric Alps.

been determined by Cushman[2] as *Campoplex lugubrinus* Hgn. and *C. rothi* Hgn., and have been shipped to the United States in appreciable numbers.

A new species of Holocremna has been reared from larvae taken near Lille.

The species of parasite previously listed as *Phaeogenes planifrons* Wesm. was determined as *P. nigridens* Wesm. by Messrs. Cushman and Roman; that formerly called *Macrocentrus abdominalis* Fab. was determined as *M. gifuensis* Ashm. by Cushman and Gahan, and the tachinid *Exorista mitis* Meig. as *Zenillia mitis* Meig. by Aldrich; Ferriére determined the Chelonus parasitic on *Pyrausta nubilalis* as *Chelonus inanitus* L.

Other features of interest but of minor importance are the rearing of *Eupelmus urozonus* Dalm. from the cocoon of *Dioctes punctoria* in the Mediterranean Zone; *Habrocytus* sp. from *Masicera senilis*, *Dioctes punctoria*, and *Microbracon brevicornis* in the Padovian Zone near Bergamo, Italy; and a pteromalid from *M. senilis and D. punctoria* in the same zone. Several other as yet undetermined hyperparasites have also been bred from the European corn borer.

FACILITATING THE REMOVAL OF THE SPRAY RESIDUE

By R. H. Robinson, *Chemist, Oregon Experiment Station*

Abstract

A brief resumé, concluded from practical and laboratory observations, is given of conditions that prevent the effective removal of spray residue by the chemical process. Of the factors that retard the solvent action, the settling of dust on the lead arsenate in the calyx and stem end of apples seems most difficult to overcome.

In order to facilitate the removal of residue, numerous compounds were mixed with lead arsenate and applied to apples as a combination spray. The fruit sprayed with the various combinations were then treated in acid to learn what materials aided the solvent action of the acid.

During the harvest season of 1927, the fruit industry adopted for the first time a chemical process for the removal of excessive amounts of spray residue. In general, unexpected success attended the use of the various solvents employed. Throughout most of the fruit districts, however, factors complicated the problem and prevented the effective removal of the residue from part of the crop. Where more than .01 grain[1] arsenous oxide per pound of fruit, permitted by health authori-

[2]Ferrière had earlier determined *Campoplex lugubrinus* as *Angitia armillata* Grav. and *C. rothi* as *Omorgus ensator* Grav.

[1]Since both the U. S. and foreign government officials use the apothecaries' system in reference to the arsenic tolerance of food stuffs, the grain unit of weight will be employed throughout this paper.

ties, was found after the acid treatment the causes for failure to clean were investigated. The principal offending conditions may be explained briefly as follows:

1. Wax secretions on fruit in excessive amounts coat the lead arsenate particles and prevent the effective removal of the residue by solvent treatment.

Fruit, especially certain varieties of apples, that is allowed to hang on the tree after the proper harvest time or that is stored at common storage temperatures after picking soon develops enough wax to protect the spray particles from the solvent action of the acid. While an increase in the temperature of the solvent softens the wax and accelerates the chemical action, heavily sprayed fruit on which excessive amounts of wax has formed cannot be cleaned below the .01 tolerance. If the fruit is harvested at the proper time and processed in the washing machine immediately after picking the difficulty may be avoided.

2. Oil spray that still remains on the fruit at harvest time likewise protects the residue from the solvent action of the acid or other solvent and prevents effective cleaning.

When certain grades of oil spray are applied in combination with or after heavy applications of lead arsenate, the combined residues form a compact mass especially in the calyx and stem end of the fruit. Unless sufficient time before harvest is allowed for volatilization of the oil the residue cannot be dissolved effectively. How near harvest time oil sprays may be used without interfering with the removal of the residue cannot be definitely stated. This depends upon the grade of oil, weather condition and amount of oil used. The proper use of the correct grade of oil will, however, prevent complications in its effect upon the removal of the spray residue.

3. Excessive deposits or large spots of residue on fruit cannot always be removed below the .01 tolerance by processing once thru the commercial fruit washing machines.

When an abnormally heavy spray schedule is followed throughout the growing season thick spots of residue accumulate especially in the calyx and stem end of the fruit. Since the cleaning of such fruit requires a longer exposure to the solvent action of the acid, a second treatment thru the machine is necessary to remove the residue. This difficulty may therefore be avoided by a more rational use of spray.

4. Deposits of dust, sand, or other air-borne particles on the spray residue retard solvent action and prevents effective cleaning.

When clean cultivation of orchards is practiced and windy climatic conditions prevail, abnormal amounts of dust particle permeate the airs.

After an application of spray, the dust settles on the wet fruit and forms a tenacious film of residue. If air particles settle on wet spray after or during several spraying operations the layer of residue is so thick that the acid treatment in washing machines cannot dissolve the arsenate protected by the dust layer. During 1927 this was found especially true of those fruits hanging in such a position that the stem end cavity retained excessive amounts of spray run off and dust. Fruit in this condition was processed three times through one of the commercial washing machines without successfully removing the residue below the .01 tolerance.

Of the conditions described above that influence the removal of the residue, the complications caused by dust deposits are most difficult to overcome. The purpose of the work reported in this paper, therefore, was to find some means of facilitating the removal of spray residue from fruit that is difficult if not impossible to clean below the .01 tolerance.

Experimental

The phase of the work reported herein pertains to the effects of various materials on the release of lead arsenate from the fruit by acid treatment. The compounds selected were mixed with the lead arsenate and the combination applied to the fruit as a spray. Two or three applications of the spray mixture were made, allowing each one to dry before the next was applied. The spray was applied with an atomizer, care being taken to spray all fruits as nearly alike as possible. The lead arsenate was used at the rate of two pounds to one hundred gallons of water in all of the experiments. Newtown apples of uniform size were used throughout all of the tests.

In the first series of laboratory observations the various combinations given in Table 1 were sprayed on the fruit. The fruit was then stored at common storage temperatures for seven days. In order to compare the rapidity with which the different spray combinations dissolved from the fruit, each lot of fruit was rotated in .5% hydrochloric acid for exactly one minute. The temperature of the acid solution was maintained at 22° C. Analyses were then made to determine the amount of arsenous oxide still adhering to the fruit. Table 1 reports the amount of arsenous oxide on the apples before and after treatment in the solvent.

In the series of observations reported in Table 1 compounds were selected that would dissolve quickly in .5% hydrochloric acid. Some of these chemicals are very water soluble while others are only slightly soluble. From the results of the analyses it is apparent that the various compounds, when mixed with lead arsenate, influence appreciably the

TABLE 1. RESIDUE ON APPLES, BEFORE AND AFTER TREATMENT IN HYDROCHLORIC ACID, SPRAYED WITH COMBINATIONS OF LEAD ARSENATE AND VARIOUS CHEMICALS

Combination Used	Length of Treatment in Acid Minutes	Per cent Acid %	As_2O_3 Before Treatment Grain per Lb.	As_2O_3 After Treatment Grain per Lb.
Lead arsenate only, 2–100	1.0	.5	.121	.051
Lead arsenate only, 2–100	1.0	.5	.092	.038
Lead arsenate+$CaCO_3$, 4–100	1.0	.5	.108	.003
Lead arsenate+$Ca(OH)_2$, 4–100	1.0	.5	.087	.004
Lead arsenate+Bordeaux, 4–4–50	1.0	.5	.089	.003
Lead arsenate+Com. Bordeaux, 10–100	1.0	.5	.084	.004
Lead arsenate+$(Al)_2(SO_4)_3$, 1–100	1.0	.5	.078	.041
Lead arsenate+$(Al)_2(SO_4)_3$, 3–100	1.0	.5	.080	.048
Lead arsenate+$Ca(C_2H_3O_2)_2$, 4–100	1.0	.5	.099	.031
Lead arsenate+$CaCl_2$, 4–100	1.0	.5	.106	.022
Lead arsenate+$CaSO_42H_2O$, 4–100	1.0	.5	.082	.017
Lead arsenate+$Ca_3(PO_4)_2$, 4–100	1.0	.5	.102	.018
Lead arsenate+$K(C_2H_3O_2)$, 4–100	1.0	.5	.084	.019
Lead arsenate+$NaNO_3$, 4–100	1.0	.5	.091	.014
Lead arsenate+Na_2CO_3, 4–100	1.0	.5	.098	.032
Lead arsenate+$MgCl_2$, 4–100	1.0	.5	.062	.003
Lead arsenate+$BaCl_2$, 4–100	1.0	.5	.108	.067
Lead arsenate+Com. spreader No. 1, 2–100	1.0	.5	.071	.059
Lead arsenate+Casein-lime spreader, 1–100	1.0	.5	.072	.006
Commercial Lead arsenate No. 1 containing spreader, 2–100	1.0	.5	.088	.042
Commercial Lead arsenate No. 1 + $Ca(OH)_2$, 4–100	1.0	.5	.058	.003
Commercial Lead arsenate No. 2 containing spreader	1.0	.5	.085	.050
Commercial Lead arsenate No. 2+ $CaCO_3$, 4–100	1.0	.5	.081	.009

solvent action of the acid. Some materials were very beneficial in aiding the removal of the residue while others indicated a retarding effect.

Outstanding among the materials that unquestionably facilitate the removal of the residue were calcium carbonate, calcium hydrate, and Bordeaux mixture. The manner in which these combinations with lead arsenate facilitated the removal of the residue is worthy of especial note. The action was both chemical and mechanical. Since these compounds dissolve very rapidly in hydrochloric acid, the lead arsenate, which dissolves more slowly, is released and falls away from the surface of the

fruit. It subsequently dissolves in the acid. In addition to this solvent release of the lead arsenate particles, calcium carbonate reacts with the hydrochloric acid, liberating carbon dioxide that mechanically lifts the residue spots that then drop from the fruit into the acid.

In the second series of laboratory observations an effort was made to imitate orchard conditions where the dust settles on the fruit between spray applications and forms a thick film of residue. Celite, a very fine silicious material, was used as the dust. This was applied as a spray after the first application of lead arsenate. In subsequent applications of lead arsenate the Celite was mixed with the latter.

Difficulty was experienced in obtaining equivalent amounts of the arsenate on the fruit, since the Celite coating presented a misleading appearance. As in the previous series, the fruit, sprayed by the various combinations, was stored at room temperature for seven days, and then treated with hydrochloric acid for the removal of the residue. Table 2 indicates the various combinations, together with the amount of arsenous oxide on the fruit before and after treatment in the acid.

TABLE 2. RESIDUE ON APPLES, BEFORE AND AFTER TREATMENT IN HYDROCHLORIC ACID, SPRAYED WITH COMBINATIONS OF LEAD ARSENATE, VARIOUS CHEMICALS AND CELITE POWDER

Combination Used	Length of Treatment in Acid Minutes	Per cent Acid %	As_2O_3 Before Treatment Grain per Lb.	As_2O_3 After Treatment Grain per Lb.
Lead arsenate, 2–100	1.0	.5	.154	.031
Lead arsenate+celite	1.0	.5	.150	.060
Lead arsenate+celite+$CaCO_3$, 4–100	1.0	.5	.147	.007
Lead arsenate+celite+$Ca(OH)_2$, 4–100	1.0	.5	.132	.009
Lead arsenate+celite+Bordeaux, 4–4–50	1.0	.5	.108	.012
Lead arsenate+celite+Com. Bordeaux, 10–100	1.0	.5	.112	.015
Lead arsenate+celite+$MgCl_2$, 4–100	1.0	.5	.059	.007
Lead arsenate+celite+Casein-lime spreader	1.0	.5	.068	.028
Lead arsenate+celite+Com. spreader, 2–100	1.0	.5	.063	.055
Lead arsenate+celite+$CaSO_4 2H_2O$, 4–100	1.0	.5	.114	.032

The retarding effects of Celite on the solubility of lead arsenate are apparent from a comparison of the analyses after treatment in the acid. When Celite was used about double the amount of arsenic remained on the fruit.

Combinations using calcium carbonate, calcium hydrate or Bordeaux were very effective in aiding the removal of the residue where Celite dust had been used in combination with the lead arsenate. The calcium hydrate apparently had changed over to the carbonate form, since in these treatments the heavy spray deposit scaled from the fruit almost immediately upon contact with the acid. The mechanical lifting action of the carbon dioxide generated from the calcium carbonate was plainly visible.

Various other combinations were observed but are not reported in Table 2. The visible residue after treatment in the acid was taken as an indication of the solubility of various combinations, none of which showed beneficial effects.

Summary

In considering the results reported in this paper it must be kept in mind that the observations were carried on under laboratory conditions. The acid treatment for removal of the residue of the fruit sprayed with various combinations was limited to a short time in order to emphasize the differences in the solubility of the various combinations. When the acid treatment was continued for two or three minutes most of the combinations were effectively removed.

In general it may be concluded that any compound or substance that is insoluble or only slightly soluble in water and yet very soluble in .5% hydrochloric acid, will best facilitate the removal of the residue by the acid treatment process. Calcium carbonate, calcium hydrate and Bordeaux mixture have these properties. For practical use one or two pounds of hydrated lime to each hundred gallons of lead arsenate spray should aid materially in the removal of the residue.

THE APPLE APHID AND THE CITRUS APHID: *APHIS POMI* DEGEER AND *A. SPIRAECOLA* PATCH

By Edith M. Patch, *Maine Agricultural Experiment Station*

Abstract

Various entomologists publishing on the citrus aphid, use the name *Aphis spiraecola*. For the convenience of those who wish to retain this name in economic literature, certain food plants, previously recorded by the writer for *A. pomi*, are here indicated for the race overwintering on *Spiraea* and commonly known as the citrus aphid.

For reasons definitely recorded at the time, I stated a few years ago with reference to the two names that form the sub-title to this paper:

"My own present interpretation of the situation is that we are concerned with one very variable species. . . ."[1]

From correspondence with certain other entomologists most familiar with this problem, I find that they believe, with me, that the apple aphid and the citrus aphid originated from a common ancestor and that the diverging forms have not yet gone far on their separate ways. They are of the opinion, however, that each "race" is entitled to its own name as a species.

Indeed, in cases where two races of an insect are conspicuously concerned with two distinct economic crops, there are obvious advantages in two names. For this reason the names "apple maggot" and "blueberry maggot" have been bestowed on *Rhagoletis pomonella* Walsh in economic publications; and certain entomologists would feel glad if the smaller blueberry race might be supplied with a distinct scientific name.

For the convenience, therefore, of such entomologists as retain the name *Aphis spiraecola* for the citrus aphid, the following statement is made concerning the food plants listed in bulletin 313 (pages 49–52).

The following accession numbers refer to typical *Aphis pomi* which normally overwinters on *Pyrus:* 52–22, 68–23, on *Pyrus Aucuparia;* 690–23, 698–23, on *P. communis;* 200–22 sub 1a, 437–22, 524–23, on *P. japonica;* 323–22, 327–22, 302–23, 350–23, 579–23, 646–23, 704–23, on *P. Malus;* 330–22a, b, on *Spiraea van Houttei*, progeny of transfers from *Pyrus*.

The other accession numbers in the bulletin refer to the race overwintering on *Spiraea* which may be indicated as *Aphis spiraecola*.

UNITED STATES INSECTICIDE STATISTICS FOR 1928

By R. C. ROARK, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

Statistics of the production of insecticides and fungicides in the United States are no longer issued by the Bureau of the Census, owing to the lack of cooperation on the part of some of the manufacturers in supplying data.

Statistics of the 1927 and 1926 production in the United States of calcium arsenate, lead arsenate and Paris green by 19 companies operating 22 plants are as follows:

[1]1923. Edith M. Patch. The Summer Food Plants of the Green Apple Aphid. Me. Agr. Exp. Sta. Bul. 313, p. 56.

TABLE 1. PRODUCTION AND CARRY-OVER OF CALCIUM ARSENATE, LEAD ARSENATE, AND PARIS GREEN IN THE UNITED STATES FOR 1927 AND 1926

	Production Year Ended (Pounds)		Stocks on Hand (Pounds)	
	Aug. 31, 1927	June 30, 1926	Aug. 31, 1927	June 30, 1926
Calcium arsenate.....	18,715,563	5,363,320	11,632,910	6,172,446
Lead arsenate: Powder.	18,359,122	16,573,784	3,660,429	1,981,133
Paste...	368,932	324,430	26,034	13,400
Paris Green.....	5,743,048	2,863,691	1,829,247	1,164,297

No reports were received from three companies which, according to the records of the Department of Commerce, are engaged in the manufacture of insecticides. No close estimate is possible, but it is roughly estimated that the figures given in the statement above represent not less than two-thirds of the total production of insecticides in the United States.

On this basis the 1927 production of these three arsenicals was: calcium arsenate, 27,000,000 pounds; lead arsenate, 27,000,000 pounds, and Paris green, 8,500,000 pounds.

Figures on the production for use as insecticides or fungicides of fluorine compounds, lime sulphur solution, sulphur dusts, Bordeaux mixture, liquid hydrocyanic acid, calcium cyanide, carbon disulphide, carbon tetrachloride, chloropicrin, oil emulsions, soaps, etc., are not available.

Statistics of the imports and exports of some of the principal insecticidal and fungicidal materials are presented in the following table. These figures were obtained from the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, and the Oil, Paint and Drug Reporter, New York, N. Y.

Pyrethrum flowers form the largest item in the imports of insecticides. These are increasingly used in the preparation of fly sprays and household insecticides.

Relative to exports, Earle C. Taylor (Commerce Reports, March 4, 1929, No. 9, p. 566) states "exports of all types of insecticides, germicides, disinfectants, and deodorants from the United States during 1928 were valued at $6,365,000, as compared with $5,109,000 in 1927, an increase of nearly 25%. The major gain occurred in the sales of household insecticides. The consumption of agricultural insecticides and animal disinfectants throughout the world is increasing."

South America, Europe, and North America in the order named took most of the exports of insecticides from this country during 1928. Argentina took $1,334,280 worth of household insecticides. Peru took

TABLE 2. UNITED STATES IMPORTS AND EXPORTS OF INSECTICIDES AND FUNGICIDES IN 1928

Material	Imports		Exports
	Pounds	Dollars	Dollars
White arsenic	21,088,785	814,822	——
Arsenic acid	11,525	425	——
Lead arsenate	——	——	141,235
Calcium arsenate	——	——	67,151
Paris green	5,457*	245*	——
Sodium fluoride	1,162,155	65,275	——
Sodium fluosilicate	3,529,084	99,057	——
Copper sulphate	2,240,608	107,822	455,023
Quassia	2,030,341	15,049	——
Tobacco extracts—excepting nicotine sulphate	——	——	513,174
Nicotine sulphate	——	——	89,559
Pyrethrum flowers, crude	11,377,445	2,425,171	——
do (advanced in value)	68,721	16,199	——
Hellebore	696,467	54,033	——
Sheep dip	136,200	13,755	——
Fly paper and fly traps	——	——	138,635
Agricultural insecticides and fungicides (not elsewhere specified)	——	——	663,425
Household insecticides and disinfectants	——	——	4,434,682
Cyanide salts and mixtures	227,095	98,906	——

*Includes London purple.

$25,000 of calcium arsenate, presumably for dusting cotton by airplane Europe took most of our nicotine sulphate and tobacco extracts, Germany alone taking more than 50% of the total United States exports of these products in 1928.

The increasing use of insecticides is due to a growing realization of the enormous damage caused by insects and to a determination to combat them in the most effective way.

A SHORT REVIEW OF ECONOMIC ENTOMOLOGY IN FINLAND

In 1898 an Agricultural Economic Faculty Section was founded in the University of Helsinki. Its staff included, among others, an (ADJUNCTUS ASSOCIATE PROFESSORSHIP?) The interim chair was occupied by Dr. *Enzio Rafael Reuter* up to 1901, who in that year was appointed to the office of ordinary professor which he held until 1913. He was succeeded by Dr. *Walter Mikael Linnaniemi*, Prof. E. Reuter being appointed professor of theoretic zoology in the Physics Mathematic Section of the University in 1910, although in the beginning he continued his former professorship together with his ordinary office. In 1921 Dr. Linnaniemi

received an EXTRAORDINARY PROFESSORSHIP IN AGRICULTURE AND FOREST ZOOLOGY, but shortly after was offered a professorship in zoology in the newly established University at Turku, which he accepted. In place of Dr. Linnaniemi at Helsinki came Dr. *Uunio Saalas*, which chair he still holds. Previously, Dr. Saalas had been a don or SPECIAL LECTURER (DOCENT) IN FOREST ENTOMOLOGY at the University of Helsinki, from 1919 to 1925.

From the beginning a small AGRICULTURAL ENTOMOLOGIC LABORATORY for research and teaching purposes was established for the associate professor of entomology in Helsinki, which was gradually extended, and in 1921 was called THE INSTITUTE OF AGRICULTURAL AND FOREST ZOOLOGY. The head of the Institute is at present the professor of agriculture and forest zoology, Dr. Saalas, who has one ASSISTANT to aid him. The institution has various collections of insects and birds, and a small reference-library, mainly entomological.

In 1898 an AGRICULTURAL ECONOMIC EXPERIMENT STATION was founded in connection with the Helsinki University, which also included an entomological section. In the beginning, however, this section worked in the quarters of the agricultural entomologic laboratory, but in 1910 it obtained its own premises at Jokiniemi (Anás), Tikkurila, about nine miles from Helsinki. Its leader at first was the adjunct of entomology in the University of Helsinki (first E. Reuter, later W. A. Linnaniemi), who also acted as STATE ENTOMOLOGIST, leading the preventive work in the rural districts and making trips when necessary to the ravaged centers.

In 1924 the Agricultural Economic Experiment Station at Tikkurila was separated from the University of Helsinki and founded as an independent institution, with a special section for injurious insects (and animals) subordinate to it. In this injurious animal section there are at present the offices of DIRECTOR, an ASSISTANT and TWO SPECIAL ASSISTANTS, besides several temporary workers. The first assistant at present is *Yrjö Hukkinen*, M. Ph., who temporarily is acting as director, which office is vacant. Special assistants are *Niilo Vappula*, M. Ph., and *Jaakko Listo*, M. Ph.

The section for injurious animals has at its disposal a laboratory, scientific collections, quite a good entomological library, and other instruments of work. Its function is to carry on research work and experiments in prevention, and to take steps to prevent the entrance into the country of harmful animals, organizing preventive measures when necessary.

As needed, temporary field laboratories have been established for several summers at the centres exposed to severe ravages.

For obtaining information from various parts of Finland regarding injurious insects a system of information has been organized, which in certain years has comprised 700 to 800 REPORTERS.

From 1894 to 1916 yearly reports have been issued in both the Finnish and Swedish languages, about the damage done in various districts, most of them under the name of REPORTS ABOUT THE APPEARANCE OF DESTRUCTIVE INSECTS IN FINLAND IN THE YEARS ————[1] (first edited by E. Reuter, later by W. M. Linnaniemi). Because of a difficult economic crisis the publication of these reports was discontinued in 1916, but later Professor Linnaniemi wrote a resumé about the destruction done by insects from 1917–1923, which is to be published soon. It is hoped that these reports will be followed by others and the work of publication continue regularly in future.

In the reports of 1894–1912 the number of species of destructive insects presented in the report varied annually from 20 to 50; from 1913–1916, when the number of reporters was larger, approximately between 100 and 200. Up to 1918 no less than 400 species of insects have been observed in Finland as harmful to cultivated plants.

It is not possible here to mention more than a few of the MOST IMPORTANT INJURIOUS INSECTS OF AGRICULTURE- AND FOERST-ECONOMY, or groups of same whose habits and life have been investigated by us in Finland and about which more important works have been published. Of these may be mentioned:

Blitophaga opaca L., Coleopt., Silphidae.

Elateridae (investigated by U. Saalas).

Phaedon cochleariae F., Coleopt., Chrysom. (Appeared in Finland only within the last decade, and found very dangerous for cross-flower (cruciferae) plants, especially turnips; investigated in detail by Y. Hukkinen who is preparing an extensive work on same).

Halticinae, Coleopt., Chrysom. (especially a few species of Phyllotreta on cross-flower plants).

Ipidae, Coleopt. (amongst others *Blastophagus piniperda* L., *Bl. minor* Hart. and *Ips typographus* L. U. Saalas has written an extensive work in the Finnish language on this subject, which has a comment in German: Über die Borkenkäfer und den durch sie verursachten Schaden in den Wäldern Finnlands).

Beetles living in spruces (*Picea excelsa*): (Dr. U. Saalas has written a book of 2 volumes on this subject: Die Fichtenkäfer Finnlands I–II).

Thysanoptera (investigated by O. M. Reuter, E. Reuter and Y. Hukkinen).

Pieris brassicae L.—Lepid., Rhopaloc.

[1]Kertomuksia tuhohyonteisten esiintymisesta suomessa vuonna . . . Berättalser öfver skadeinsekters upptradande i Finland ar . . .

Chareas graminis L., Lepid., Noct. (Caused great damage in meadows, especially in former years, for example in 1891–1893, but now and then also in later years. Studied by O. M. Reuter, E. Reuter and others, who have published several books about them).

Hadena secalis Bjerk., Lepid., Noct.

Panolis griseovariegata Goeze, Lepid., Noct. (now and then serious damage in pine woods. Investigated by P. W. Hannikainen, U. Saalas, and others).

Cheimatobia brumata L., Lepid., Tortr.

Laspeyresia nigricana Steph., Lepid., Tortr.

Carpocapsa pomonella L., Lepid., Tortr.

Plutella maculipennis Curt., Lepid., Tin.

Argyresthia conjugella Zell., Lepid., Tin.

Hylemyia (Phorbia) brassicae Beh., Dipt. (great damage often done to cabbage plants).

Pegomyia hyoscyami Panz., Dipt. (great damage, especially to sugar beets).

Chlorops pumilionis Bjerk., Dipt.

Oscinella frit L., Dipt.

The sources of bleached earing have been specially studied by E. Reuter who has published a work about them: Über die Weissährigkeit der Wiesengräser in Finnland.

Leaf miners have been specially investigated by W. M. Linnaniemi who to date has published a treatise: Zur Kenntnis der Blattminierer speziell derjenigen Finnlands I.

Finally I may mention that in 1925 a law was passed to protect plant-life in Finland, giving the section on injurious animals in the agricultural experiment institute the necessary power to take steps to prevent the invasion of the country by harmful animals and to take preventive measures. In 1928 the Council of Ministers altered the antiquated laws against poisons. At present such poisons containing arsenic, quicksilver, nicotine, syan, phosphor, and strycknine, which come in the class of plant-protection poisons, are freed from prohibitory measures and may be used for agricultural and garden-cultivation purposes.

UUNIO SAALAS.

Scientific Notes

The Westward Spread of *Samia cecropia* (L).—The native species of *Samia* in the Rocky Mountains is *S. gloveri* (Strecker), but in Packard's monograph of the Saturnûdae (1914) it was shown that *S. cecropia* extended all over Nebraska and had been taken at Helena, Montana. In my Zoology of Colorado (1927) it is recorded that *S. cecropia* has reached the eastern plains of Colorado, and is reported as very destructive. This year (1929) Mr. J. H. Shiner found a *Samia* cocoon on the golf links at Boulder, Colorado, and it has just (July 1) produced a characteristic *S. cecropia*. Thus *S. cecropia* has spread into the territory of *S. gloveri*, and it remains to be seen whether it will increase and become a pest, whether it will affect the abundance of *S. gloveri*, and whether any hybrids will be formed. The two species are well known to cross in a state of domestication.

Since writing the above, I have been handed several other specimens of *Samia cecropia* found this year in Boulder. It is evidently well established.

T. D. A. COCKERELL

Mexican Bean Beetle, *Epilachna corrupta* **Muls.** There has been a general and apparently widely scattered distribution of this insect in southeastern New York and western Connecticut, since it was taken in July at Babylon, Huntington and near Westbury, Long Island and at North Salem, N. Y., and at Stamford, Darien, New Canaan, Ridgefield, Wilton, Westport, Brookfield and Washington, Conn., without ascertaining the apparent limits of this most recent extension of infested territory. Most of the work observed was in somewhat widely scattered bean patches and in many cases the injury was limited to a few plants or group of plants. The infestations were apparently of very recent origin, since no old adults were found and a very few young larvae were observed, although most of them were nearly full grown and there were a number of pupae.

E. P. FELT, *Bartlett Tree Research Laboratories*

A New Material Used to Cage Insects on their Host Plants.—While studying the life history of the Mealy Plum Aphid, *Hyalopterus arundinis* Fabr., the author, after trying several types of cages, finally adopted a cage made of a transparent cellulose paper, sold under the name of Cellophane. This material is on the market in flat sheets and can be made into any size or shape of cage desired. For the cages used in the study of the Mealy Plum Aphid, the paper was cut into long strips four inches wide and sixteen inches long. These were folded in the middle with the fold in the direction of the width. The free edges were glued with waterproof cement, to form a simple bag. The twig supporting the aphids was inserted into the bag and the mouth was closed by tying with string around cotton wrapped around the twig at the open end of the cage.

This material has certain features which make it very satisfactory for caging insects on plants, the chief of these is that it is permeable to atmospheric moisture. This prevents the condensation which commonly occurs in glass cages. So it both allows a good view of the interior and approximates natural humidity, a point of considerable importance in life history studies. The Du Pont Company (manufacturers of this material) inform me that the transparency of this paper to ultra violet rays is practically the same as quartz glass. Temperature readings inside of a paper cage on a tree, inside a glass flask plugged with cotton on a tree, and outside are as follows:

June 7, 1929	Flask	Paper cage	Outside
9:00 a.m.	27.7°C	22.8°C	17.0°C
10:00 a.m.	30.4	25.7	19.0
11:00 a.m.	28.0	25.2	19.0
12:00 a.m.	30.4	29.2	19.6
1:00 p.m.	24.0	23.8	18.4
2:00 p.m.	19.5	19.0	17.2
3:00 p.m.	37.0	36.6	22.0
4:00 p.m.	27.1	27.4	19.5
5:00 p.m.	18.0	17.0	16.8

The paper is manufactured in six different thicknesses. The most satisfactory was the so-called number 600 which is about .0017 inch thick.

The material has the disadvantage of becoming very soft and pliable in a heavy rain, and the cage is apt to collapse onto the plant. Also in very dry weather the paper may occasionally crack in a heavy wind.

LESLIE M. SMITH, *University of California*

Norway Maple Leaf Stalk Borer, *Nepticula sericopeza* **Zeller.** This European insect, kindly determined by Dr. August Busck, is well established in Stamford, Conn. and infested leaves were received last year from New Hamburg and White Plains, N. Y. There were reports of probable infestations from other localities. The tiny larvae work at the very base of the leaf stalks. Infestation is indicated by a slight swelling of the enlargement next the twig accompanied by an obscure sooty discoloration and usually a minute white speck, presumably coagulated sap, about the size of a pin head. Our observations indicate that the borings of this insect are practically limited to the basal half inch of the leaf stalk. This newly discovered introduction may cause the dropping in June of as much as ten per cent of the leaves. The infestation is fairly uniform throughout the leafage of even large trees. It is quite possible that earlier heavy dropping of leaves charged to dry weather or plant lice may have been caused in part, at least, by this borer. Dr. Busck states that this species is recorded as mining the young fruit of Acer in Europe.

E. P. FELT, *Bartlett Tree Research Laboratories*

An Entomologist's Handbook Needed.—While reading the interesting address of Dr. Herms given at the New York meeting, the writer was again reminded of a real need in entomological work. I refer to an Entomologist's Handbook which would contain a compilation of laboratory and field devices used in insect work, rearing equipment, methods of procedure, manner of checking experiments, etc. While entomologists, in general, have worked out suitable equipment and procedure for their problems in hand, they are continually attacking new problems or old problems in a new light. It would effect a great saving of time and might make for better experimental work, if there were available a compendium of this information which would form a starting point for devising equipment and procedure for special needs.

Entomologists have occasionally referred to this need and it was rumored some time ago that several men were contemplating the preparation of such a work, but it is not known to most of us whether this is being done. To make it most valuable, everyone should be given a chance to submit drawings and descriptions of special apparatus which he has devised or found useful. There should be brought together, published accounts and illustrations of apparatus which have been devised for special needs. Such a book would be particularly valuable to beginners in experimental entomology. Our science is rapidly entering the experimental stage as the treatment of published papers clearly indicates. A well prepared handbook of this nature would be a necessary part of the library of practically every entomologist. It would offer for a publishing house a better financial proposition than the already well supplied field of general text books.

ROGER C. SMITH, *Director Ecole Centrale, Entomologist Service Technique*

JOURNAL OF ECONOMIC ENTOMOLOGY

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AUGUST, 1929

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1929–30, Des Moines; 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

The occurrence of the Mediterranean fruit fly over considerable areas in Florida, even though many of the infestations are sparse, forces upon American entomologists a problem of the first magnitude. The Secretary of Agriculture has done well to recognize this in the recent appointment of leading specialists from various parts of the country in order that the policy of the Department may be guided by a representative opinion which cannot but carry the greatest possible weight. The wide distribution of the insect is bound to raise grave concern as to the possibility or the practicability of eradication and the feasibility of restricting spread, in case eradication is deemed impossible, raises another series of problems which cannot be readily settled. The physical features of the problem are of more than ordinary interest. The infested region comprises some 54 per cent of the land area of Florida. It contains 72 per cent of the bearing citrus trees and based upon a three year average, 80 per cent of the carload shipments of citrus fruit originate in this territory. The annual income from the citrus crop and other host crops which may be affected by the fly is upward of $60,000,000, and the capital investment exceeds $300,000,000. Despite the difficulties, the committee has endorsed a program of eradication and out-

lined the conditions believed necessary for its successful conclusion. We note among others, provision for treating and marketing of the crop. This is extremely important in a dominant industry, if we would avoid very serious economic disturbances and presumably make eradication impossible. This latter is not the work of one year and can hardly be accomplished within a relatively few years. All concerned should recognize fully the importance of 100 per cent effectiveness all along the line. It is the weak link which determines the strength of a chain.

Reviews

Ants, Bees, and Wasps, A Record of Observations of the Habits of the Social Hymenoptera by SIR JOHN LUBBOCK (LORD AVEBURY), New Edition, Based on Seventeenth, Edited and Annotated by J. G. Myers, pages I–XX, 1–377, 31 text figures, 4 colored plates, E. P. Dutton and Company, New York, 1929.

The republishing of this well known popular and most interesting work which has already run through 17 editions and was first issued nearly 40 years ago is noteworthy in entomological annals and would be inadvisable in a volume devoted largely to systematic or taxonomic matter. The continued popularity of Lubbock's work depends in large measure upon the fact that he is dealing with social insects, always of great human interest and also that in this volume he has given an excellent exposition, with many intensely interesting records, of methods of observation upon the habits and instincts of insects. The mere fact that he was dealing with social insects presenting certain analogies to human activities appeals strongly to a wide range of readers. Lubbock has given an admirable series of observations upon common and easily obtained insects. He demonstrated the possibility of keeping these under controlled conditions for a series of years,—some nests being observed over seven years and individual workers for a period of five years. It is stated that he kept in captivity about half of the known English species of ants. This volume also contains interesting observations upon bees and wasps and is of great value as a guide to similar studies of these and other insects. Lubbock's annotations are included. These are supplemented by numerous notes by the editor bringing the book down to date so far as is necessary. There is also a well selected and comprehensive bibliography. This edition should have a wide circulation in America.

E. P. F.

Pests and Diseases of Queensland Fruits and Vegetables by ROBERT VEITCH and J. H. SIMMONDS, pages 1–198, 69 plates (6 colored) Division of Entomology and Plant Pathology, Queensland Department of Agriculture and Stock, 1929.

This general work on insects and plant diseases will be of especial service to those working under subtropical conditions. There are general chapters in relation to

insects and their relatives, insect anatomy, fungi and fungicides and discussions of the more important forms affecting deciduous fruits, citrus fruits, bananas, pineapples, tomatoes, vegetables and general pests.

The Entomologist will be particularly interested in the account of the Queensland fruit fly, especially as the Mediterranean fruit fly has been recently discovered in the southeastern United States. The authors add that this latter insect does not occur in Queensland, though it is very common in the neighboring state of New South Wales. There is also a somewhat full account of the banana fruit fly (*Choetodacus musoe*). Considerable space is given to injurious Hemiptera, such as the bronzy orange bug (*Oncoscelis sulciventris*) and the Rutherglen bug (*Nysius* sp.) and several fruit spotting bugs (*Pendulinus* sp.), these being suggestive of injury caused by several American pentatomids, especially in the south. The cosmopolitan corn ear worm is destructive in that section of the world and the same is also true of two species of leaf eating lady beetles (*Epilachna*). The numerous illustrations are admirable and the volume gives an excellent summary of entomological and pathological conditions in the antipodes.

E. P. F.

A Manual of External Parasites by HENRY ELLSWORTH EWING, pages I to XIV, 1–225, 96 text figures, Charles C. Thomas, Springfield, Ill., Baltimore, Md., 1929.

This manual of external parasites of man and other animals brings within a smal compass a resumé of available information respecting these important groups by an acknowledged leader in this field. The scope of the volume is indicated by the groups considered, namely the mites, the better known ones being the Gamasids, the Harvest Mites, the Tarsonemid Mites, the Cheese Mites, the Scab Mites; the Ticks, the Biting Lice, the Sucking Lice, the Fleas and a somewhat unusual feature for published books, namely, descriptions of a number of new genera erected by the author. We have in this volume a series of keys and illustrations which make it relatively easy to identify the more important of the numerous species falling within the scope of the work. It was impossible within available limits to treat exhaustively the numerous species. In fact, the author ventures the opinion that the parasitic mites might outnumber the insects in species. The work is necessarily largely systematic within the respective groups, yet the author has summarized admirably the most effective control measures for the various injurious or annoying species. The illustrations are admirable, mostly original. It is the reviewer's opinion that such an illustration as figure 89 showing the heads of fleas belonging to different genera and occurring upon different hosts will prove of very material assistance to one attempting to identify these very elusive forms. There is an excellent bibliography for each of the groups.

The Entomologist will find in this an admirable guide to relatively little known mites and insects and veterinarians will find this work of great service in identifying the numerous species occurring upon domestic animals.

E. P. F.

Current Notes

Dr. L. O. Howard visited the field laboratory at Madison, Wis., on April 15.

Mr. R. H. Hanford, temporary Insect Pest Investigator, Entomological Branch, reported for duty on May 1.

Mr. I. E. Thomas, Insect Pest Investigator, Entomological Branch, reported for duty on May 28.

Prof. J. S. Houser visited the Department of Entomology of Kansas State Agricultural College on July 5–6.

Messrs. W. Dickinson and R. Fitzpatrick, temporary Insect Pest Investigators, Entomological Branch, reported for duty on May 17 and June 5, respectively.

Mr. R. H. Painter, Entomological Branch, received the degree of master of science from McGill University, at the convocation held on May 29.

Lowell A. Woodbury was appointed on April 2 as Field Assistant, Bureau of Entomology, for duty at the field laboratory at Salt Lake City.

Messrs. G. F. Manson, seasonal Junior Entomologist, Entomological Branch, and C. Farstad, temporary Insect Pest Investigator, reported for duty on May 10 and 2, respectively.

On April 23, Dr. Herbert Osborn of Ohio State University, called at the National Museum to examine types of Homoptera in the National Collection.

Stewart Lockwood, Bureau of Entomology, formerly in charge of the field laboratory at Billings, Mont., has resigned from the service, effective May 6.

Mr. A. P. Arnason, temporary Junior Entomologist, Entomological Branch, and Messrs. R. Glen and L. Paul, temporary Insect Pest Investigators, reported for duty early in April.

Dr. B. A. Porter, Bureau of Entomology of the Washington office of Deciduous Fruit Insect Investigations, visited the field laboratory at Columbus, Ohio, on April 6.

Dr. J. G. Gehring, of Bethel, Me., spent May 12 to 14 with Mr. Barber in the section of Coleoptera of the Taxonomic Unit, Bureau of Entomology.

Dr. W. J. Schoene, Blacksburg, Va., and Dr. S. B. Fracker, of the Plant Quarantine and Control Administration, Washington, D. C., visited the Japanese Beetle laboratory on May 21.

W. A. Baker, Bureau of Entomology, of the field laboratory at Monroe, Mich., spent April 8 to 10 at the headquarters for corn-borer research, at Arlington, Mass.

K. A. Haines, a graduate of Purdue University, has recently been employed to assist with Oriental Fruit Moth investigations at the Ohio Station.

Mr. James G. Conklin has been given a temporary appointment at the Agricultural Experiment Station, New Haven, Conn., and is engaged in the annual inspection of nurseries.

Mr. Henry C. Fall of Tyngsboro, Mass., well-known teacher and Coleopterist, received the honorary degree of Doctor of Science from Dartmouth College, at the recent commencement in June.

A. B. Champlain, of the Pennsylvania Department of Agriculture, Harrisburg, Pa., called at the Taxonomic Unit, May 17, to consult A. Busek about the European corn borer.

Oliver I. Snapp, Bureau of Entomology spent the week of May 20 to 26 in and around Orlando, Fla., studying the Mediterranean fruit fly situation.

Mr. H. G. Crawford, Entomological Branch, visited the Chatham and Strathroy laboratories, May 20–25, and was again at Chatham on June 9 in connection with corn borer investigations.

G. F. Knowlton, of the Utah Agricultural Experiment Station, at Logan, has recently been appointed a collaborator, Bureau of Entomology, in investigations on the sugar-beet leafhopper.

Mr. J. H. Pepper, temporary Insect Pest Investigator, Entomological Branch, reported for duty at Lethbridge, Alta., on May 27, in connection with the work of the Division.

Miss Kathleen McClure, a recent graduate of Iowa State College, has been given a temporary appointment as Senior Scientific Aid in the Taxonomic Unit, Bureau of Entomology.

W. A. Thomas, Bureau of Entomology in charge of the field laboratories at Chadbourn, N. C., visited Washington May 3 to 6, to discuss the work being conducted at that laboratory.

Mr. G. S. Walley, Entomological Branch, is collecting insects in connection with faunal studies, at Point Pelee, Ont. He is accompanied by Mr. L. J. Milne, temporary Insect Pest Investigator.

Dr. Joseph Bequaert, of the School of Tropical Medicine, Harvard University, visited the National Museum April 26 to compare specimens of blood-sucking flies and of certain diplopterous wasps.

Mr. James Marshall, Entomological Branch, has been appointed to the position of Assistant Entomologist in Nova Scotia, made vacant by the death of Mr. J. P. Spittall last year.

A. C. Fleury, Chief of the Quarantine Division, Sacramento, Calif., spent a part of May 25 looking over the investigational work on the Japanese and Asiatic beetles.

Messrs. W. E. Hemming and W. E. Lindsay, temporary Junior Entomologists, Entomological Branch, reported for duty early in June. Mr. J. A. Adams was appointed temporary Insect Pest Investigator on May 31.

Dr. J. R. Hobbs, a student at the Harvard Medical School has received a temporary appointment, Bureau of Entomology, beginning May 1, to study certain diseases of the gipsy moth.

Gordon W. Haug and Frank Lieberman have accepted three months' appointments as field assistants, Bureau of Entomology, at Salt Lake City, Utah, effective May 27 and May 15, respectively.

Mr. W. A. Squires, temporary Insect Pest Investigator, Entomological Branch, reported for duty on May 31. Mr. Squires spent the past year as a Graduate Assistant in Entomology at Ohio State University.

Mr. C. W. Collins, Secretary of the Association and Business Manager of the JOURNAL recently reported as dangerously ill from blood poisoning, is now on the road to recovery.

On May 27, Prof. J. J. Davis, of the Department of Entomology, Purdue University, Lafayette, Ind., consulted hymenopterists of the Taxonomic Unit, Bureau of Entomology, regarding parasites of the oriental peach moth.

Mr. H. F. Hudson, Entomological Branch, returned to duty in the latter part of May, after a prolonged period of sick leave following an accident to his leg, in August, last year.

Early in May, Dr. F. C. Craighead, Bureau of Entomology, spent two days at Syracuse, N. Y., consulting with Dr. M. W. Blackman and Dr. H. J. MacAloney about the work on the white-pine weevil.

Messrs. J. Z. Belanger and M. L. Prebble, Insect Pest Investigators, Entomological Branch, reported for duty in the latter part of May, the former at Trinity Bay, Que., and the latter at Fredericton, N. B.

G. J. Hauessler, Bureau of Entomology, of the field laboratory at Moorestown, N. J., called at the National Museum, April 4, to consult bureau specialists about hymenopterous parasites of the Oriental peach moth.

Frank Johnson, of New York City, came to Washington on April 2, to consult with Dr. Schaus, and to deposit in the Muesum Collection a gift of some rare species of Lepidoptera.

Professor C. L. Metcalf is spending the summer in the Adirondack Mountains studying the habits and distribution of the various species of Black Flies, under the direction of Dr. R. D. Glasgow, State Entomologist.

Mr. C. H. Curran, of the American Museum of Natural History, New York, was a visitor at Ottawa for ten days during the latter part of April, studying Tachinidae in the National Collection of Canada.

J. C. Evenden, Bureau of Entomology, reports that field activities have begun in Montana with the initiation of several control projects for the Forest Service. The late season and considerable snow have somewhat handicapped operations.

Prof. O. G. Anderson of Purdue University will spend the summer at Wooster, Ohio, where he will continue the investigation of manganese arsenate as an insecticide. This work is being financed by the Grasselli Chemical Corporation.

Mr. J. A. Hall, Entomological Branch, has spent the past two months at Simcoe, Ont., conducting life-history and oil spray control studies on apple leaf rollers. An insectary has been erected in that locality.

Temporary field assistants Bureau of Entomology appointed and reporting for duty at the Tallulah field laboratory in May were A. C. Christopher, O. H. Graham, H. D. Cook, R. W. Bunn, J. G. Shaw, C. F. Rainwater and R. P. Patty.

Mr. L. S. McLaine, Entomological Branch, visited Washington, D. C., April 22–26, to attend a hearing in connection with an outbreak of the Mediterranean fruit fly, in Florida called by the Plant Quarantine and Control Administration.

Dr. W. E. Hinds, State Entomologist of Louisiana, with headquarters at Baton Rouge, visited the field laboratory at Tallulah on May 21 for conference with B. R. Coad on conditions relating to the boll weevil in Louisiana.

On May 13 and 14, four horticultural commissioners from various counties in California, A. H. Call, Santa Paula, John P. Coy, San Bernardino, R. R. McLean, San Diego, and A. A. Brook, Santa Ana, visited the Japanese Beetle Laboratory, Morristown, N. J.

Prof. John J. Davis, Lafayette, Ind., arrived at Moorestown May 30, for conference and to collect parasites of the oriental peach moth. He will try to establish in Indiana certain native parasites now occurring in New Jersey.

Rodney Cecil, Bureau of Entomology, returned to the field laboratory at Geneva, N. Y., on April 22, where he will resume his studies on bean insects. He spent last winter in the field laboratory at Columbus, Ohio.

T. P. Cassidy, at present in charge of cooperative experimental work on control of the boll weevil in Oklahoma, spent the last few days of May at Tallulah in conference with B. R. Coad on conditions in that State.

On April, 25 Dr. E. D. Ball, Dean of the College of Agriculture, University of Arizona, at Tucson, and Director of the Agricultural Experiment Station, worked on some of the Homoptera in the collections of the National Museum.

On April 19, Prof. Geo. A. Dean, of the Kansas Agricultural Experiment Station, while en route from California to Manhattan, Kans., stopped at Salt Lake City, Utah, to confer with Geo. I. Reeves, in charge of the field laboratory there.

Gilbert A. Schenk, Associate Entomologist, Bureau of Entomology, who has been conducting at Manhattan, Kans., the bureau's work on flour-mill insects, resigned his position April 30, to engage in the commercial manufacture of fumigants, with headquarters at Kansas City.

Miss Grace Sandhouse, of the taxonomic unit, Bureau of Entomology, spent the last week of April in Philadelphia, studying bees in the collection of the Academy of Natural Sciences, particularly the Cresson types of Osmia and related genera.

W. A. Baker, Bureau of Entomology, of the field laboratory at Monroe, Mich., for the study of the European corn borer, visited the Laboratory on April 21 to study the various methods used in rearing parasites of the Japanese beetle.

Messrs. Collins, Hood, Barnes and Potts, of the Gipsy Moth Laboratory, Bureau of Entomology, discussed various matters having to do with insecticides with Dr. T. J. Headlee, of the New Jersey Experiment Station, when he visited Boston on May 10.

R. E. Campbell, Bureau of Entomology, in charge of the field laboratory at Alhambra, Calif., reported that during the period April 8 to 15, G. A. Dean, F. C. Bishopp, D. C. Parman, W. S. Abbott, W. M. Davidson, L. J. Bottimer, and D. N. Borodin, visited the laboratory.

Mr. W. J. Reid, Jr., of the Chadbourne, N. C., Truck Crop Station, Bureau of Entomology, has been transferred temporarily to the field laboratory, Columbus, Ohio, to work during the summer with D. M. DeLong who is temporarily located with that station.

Mr. Baird and his staff, formerly at the Chatham Parasite Laboratory, Ontario, engaged on parasite work, have been transferred to a laboratory newly established at Belleville and all parasite breeding stock, laboratory and office equipment, etc., have been transferred there.

H. C. Young and T. P. Cassidy, Bureau of Entomology, of the field laboratory at Tucson, Ariz., reached Stillwater, Okla., on May 6, and during the present season will be engaged in cooperative work on control of the boll weevil in Oklahoma.

Temporary appointments as field assistants, Bureau of Entomology, have recently been given G. T. York, and W. I. Duplessis assigned to duty at Alhambra, Calif., P. M. Eide and A. E. Bonn, assigned to duty at Puyallup, Wash., and R. W. Dean, assigned to duty at Geneva, N. Y.

C. M. Packard, Bureau of Entomology, in charge of investigations of the Hessian fly, with headquarters at West Lafayette, Ind., visited the field laboratory at Carlisle, Pa., on May 20 and 21, and the Washington office, on his way home, on May 22 and 23.

Harry F. Deitz has recently accepted the Crop Protection Institute fellowship lately resigned by Geo. Langford. The work will be carried on at Wooster, Ohio and will deal with the insecticidal properties of shale oil. It is financed by the Tennessee Copper Company.

Dr. Roger B. Friend, Assistant Entomologist of the Agricultural Experiment Station, New Haven, Conn., gave a brief radio talk, Wednesday, July 10, from Station WBZ, Springfield, Mass., as a part of the Thornton W. Burgess Nature League Hour. His subject was the Japanese beetle and the Asiatic beetle.

Professor P. W. Claassen of Cornell University, Dr. Bennet A. Porter, of the Bureau of Entomology, and Messrs. L. H. Worthley, H. N. Bartley, C. H. Hadley and C. W. Stockwell of the Plant Quarantine and Control Administration, were recent callers at the Department of Entomology, Agricultural Experiment Station, New Haven, Conn.

Professor F. E. Guyton is in Florida this summer helping to eradicate the Mediterranean fruit fly. His headquarters are at Sanford, Fla. Twelve of the recent graduates and 18 undergraduates of Alabama Polytechnic Institute are also working on the Mediterranean fruit fly project in Florida.

On April 19, C. I. Bliss, Bureau of Entomology, of the field laboratory at New Orleans, La., and E. O. Essig, of the State experiment station at Berkeley, Calif., were in Alhambra, Calif., and gave talks at the regular meeting of the Entomological Club of Southern California.

On April 20, R. E. Campbell, Bureau of Entomology, Alhambra, Calif., inspected lettuce fields in the Salinas Valley, where a serious aphid infestation was found; he also conferred with O. H. Lovell at San Jose, Calif., regarding the situation as to the vegetable weevil at that place.

Dr. Dayton Stoner, whose temporary appointment as field assistant, Bureau of Entomology, at the field laboratory at Sanford, Fla., expired on April 14, visited Washington April 22 to 27, to confer with bureau officials regarding his past season's work on predators, particularly birds, of the celery leaf-tyer.

Dr. N. F. Howard, Bureau of Entomology, Columbus, O., attended the spring meeting of the Tri-States Packers Association at Baltimore, Md., On April 3 and 4, where he discussed the control of the Mexican bean beetle along the Atlantic seaboard. He visited Washington en route, on his return to Columbus.

Carl Heinrich, of the Taxonomic Unit, Bureau of Entomology, sailed from New Orleans on April 12, for Guatemala, to investigate reported occurrence of the European corn borer in that country, and to study related species of Pyrausta and their parasites. He will be absent about ten weeks.

George P. Englehart, of the Brooklyn Museum, Brooklyn, N. Y., who was returning from an extensive collecting trip in Florida, stopped in Washington on April 4 to complete the arrangements which have been under consideration for the deposit of the Brooklyn Museum collection of Lepidoptera in the United States National Museum.

Dr. W. H. Larrimer, Bureau of Entomology, spent May 24 to June 1, driving through the districts infested by the European corn borer in Ohio, Pennsylvania, and Michigan, in search of first-hand information on the status of the clean-up this year as compared with that of former years.

Mr. A. B. Baird, Entomological Branch, visited Toledo, O. and Monroe, Mich., in early May in connection with corn borer parasite work. On May 8 and 9, Messrs. Baird and W. E. Steenburgh were in the Niagara district, Ont., with Mr. Ross, selecting peach orchards for experimental work with Trichogramma and other parasites.

Four college students have been given employment at the Gipsy Moth Laboratory Melrose Highlands, Mass., for the summer season, R. W. Lamson, of Syracuse University, A. L. Brady, of Cornell University, R. K. Voorhees, Florida Agricultural College, and J. G. Schread, Connecticut Agricultural College. Mr. Lamson reported March 1, and the others in May.

Adults of the parasite (*Digonochaeta setipennis*) of the European earwig, have emerged in Canada from puparia of this species received from the Farnham House laboratory, Farnham Royal, England, at the end of April. A number of these parasites have been forwarded to Mr. Glendenning at Agassiz, B. C., for liberation.

On May 16 C. Boden Kloss, of the Raffles Museum, Singapore, Straits Settlements, consulted with W. S. Fisher of the Bureau of Entomology in regard to the determination of beetles, and with A. B. Gahan and R. A. Cushman of the same division, about the parasitic Hymenoptera loaned from the collections under his charge.

Temporary appointments as field assistants, Bureau of Entomology, have recently been given C. Mattsson and H. E. Dorst, assigned to duty at Richfield, Utah, H. A. Waters and A. C. Cole, Jr., assigned to duty at Twin Falls, Idaho, Joseph Hamilton, assigned to duty at Tempe, Ariz., and L. L. Odom, assigned to duty at Grand Bay, Ala.

V. S. L. Pate, a graduate student in the Department of Entomology, Cornell University, spent April 4 to 6 examining types and other material of sphecoid wasps of the tribe Oxybelini in the National Collection. He is engaged in a revision of this tribe, and while here arranged to borrow certain specimens from the Philippine Islands.

Mr. H. S. Swingle, formerly Assistant Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, located at Fort Valley, Georgia, has recently accepted a research position with the Alabama Polytechnic Institute at Auburn, Alabama. He will spend the major portion of his time on Insect Physiology research. He reported for duty on July 1st.

J. E. Patterson, Bureau of Entomology, reports that although snow still lies on the ground in the Crater National Park, the control of the mountain pine beetle by the sun-curing method has been progressing favorably, and that unusually high temperatures for this season of the year have been obtained under the bark of the felled trees.

Mr. K. M. King, Entomological Branch, who has been engaged in post-graduate studies at the University of Minnesota, for some months past, returned to duty at the laboratory at Saskatoon on June 7. Investigations dealing with cutworms and wireworms, and rotation studies, are occupying the time of the officers of this laboratory.

In company with Dr. C. L. Marlatt, Dr. A. C. Baker, Bureau of Entomology, left Washington, D. C. on April 9 to confer with officials of the Florida State Plant Board concerning the recent outbreak of the Mediterranean Fruit Fly. Dr. Baker is now giving special attention to investigations which are necessary in the program of eradication.

Mr. Eric Hearle, Entomological Branch, spent the latter part of April studying livestock insect conditions in the south Okanagan and Similkameen districts. Data were secured regarding ticks, blackflies, mosquitoes and other livestock insects, and many specimens were collected. Mr. Hearle reported that ticks were among the outstanding pests of livestock at that time.

During the latter half of April The Western Dusters, a commercial company, have been cooperating with E. A. McGregor, Bureau of Entomology in applications of sulphur by airplane for the possible control of the citrus thrips. The preliminary calculations of the expected destruction of citrus thrips by this method seem to give considerable promise.

Messrs. J. J. deGryse and C. B. Hutchings, Entomological Branch, report excellent progress in their investigations on the maple leaf cutter which are being continued at the field laboratory at Merivale, near Ottawa. They are being assisted in this work by Messrs. R. Finlayson and J. B. Sheldon, Insect Pest Investigators. The latter reported for duty on May 31.

B. J. Landis, Bureau of Entomology, who left Columbus, Ohio, June 10 for Mexico to investigate parasites of the Mexican bean beetle, visited the Gipsy Moth Laboratory, Melrose Highlands, Mass., the Corn-Borer Laboratory, Arlington, Mass., and the Japanese Beetle Laboratory, Moorestown, N. J., early in May to study methods of rearing and handling parasites. He visited Washington May 17.

Dr. F. F. Smith, formerly with the Pennsylvania Department of Agriculture, and who has been Fellow in Entomology at Ohio State University for the past year, received the Ph.D. degree at the Spring Convocation in June. He has been appointed Associate Entomologist, Cereal and Forage Insect Investigations, Bureau of Entomology, and stationed at Arlington Farm, Rosslyn, Va.

During the week of May 15, D. W. Jones and Chas. A. Clark of the field laboratory at Arlington, Mass., Bureau of Entomology, visited the field laboratories at Silver Creek, N. Y., Sandusky and Toledo, Ohio, and Monroe, Mich., on business relating to parasites of the European corn borer. On May 22 they left the region about Lake Erie and returned to Arlington.

Three patents and a patent on a process, all concerning the drying of seed cotton, have been received in April at the division's headquarters at Tallulah. The investigations on cotton drying have been carried on by the Division of Agricultural Engineering, Bureau of Public Roads, in cooperation with the Division of Cotton Insects of the Bureau of Entomology.

Dr. M. D. Leonard, Entomologist for the Tobacco By-Products and Chemical Corporation, returned to Wenatchee, Wash., in April, where he will again spend the season conducting experiments and demonstrations on codling moth control with Black Leaf 40, chiefly in combination with summer oils. These experiments are largely in cooperation with the official workers of Washington, Oregon and Idaho.

Professors J. G. Needham, C. R. Crosby amd Paul Needham, of the Department of Entomology, Cornell University, visited the Bureau of Entomology, including the Division of Taxonomy and Interrelations of Insects, on April 1. At this time Dr. J. G. Needham returned to the National Collection a part of the Chinese dragonflies which he had borrowed for study at the time he worked in the collections last January.

W. D. Reed, Bureau of Entomology, of the field laboratory for the study of dried-fruit insects, Fresno, Calif., visited the Taxonomic Unit May 9 to consult hymenopterists regarding possible parasites of the dried-fruit beetle, which does much damage to figs. He also spent May 12 and 14 in the section of Coleoptera, examining the collection of Nitidulidae, particularly of the genera Carpophilus and Eupuraea, to obtain records of these beetles for California.

On May 7, H. S. Barber, Taxonomic Division, Bureau of Entomology, went to Wingina, Va., with J. H. Riley, of the staff of the National Museum, to pack for shipment to the Museum the collections of the late Colonel Wirt Robinson. These collections include a number of rare and unusual Coleoptera which, after they have been incorporated in the Museum collections, will be of considerable value to the Bureau specialists for purposes of reference.

Mr. E. B. Watson, Entomological Branch, left Ottawa for Trinity Bay, on the North Shore of the St. Lawrence, on May 22, to investigate the hemlock looper outbreak in that section with the cooperation of Mr. Tessier of the Quebec Forestry Branch. It is planned to conduct airplane dusting experiments in the control of the looper early in July, at English Bay, with the tri-motor airplane being used in the spruce budworm work at Westree.

Mr. W. J. Brown, Entomological Branch, left Ottawa on June 3, for Seven Islands, Que. Mr. Brown is accompanying Mr. H. F. Lewis of the National Parks Branch along the coast of Quebec and Labrador, on the north shore of the Gulf of St. Lawrence, between Seven Islands and the Straits of Belle Isle. Mr. Brown, who is making an insect faunal survey of this region, will be absent from Ottawa during the greater part of the summer.

At the present time considerable interest is manifested in the widespread destruction being wrought by termites on the foundations and interiors of buildings in all parts of the country, especially in the Central and Southern States. A recent survey of the buildings in Memphis, Tenn., by city officials, indicates that from 60 to 70% of them are infested by termites. Similar reports are being received from New Orleans, La., and other cities in the Southern States.

O. I. Snapp, Bureau of Entomology, in charge of peach-insect investigations at Fort Valley, Ga., writes that the present curculio infestation in the Georgia peach belt is the heaviest in eight years. A vigorous campaign of suppression is being waged in order to control the second generation, which will attack the matured fruit. A heavy infestation was anticipated, on account of the quantity of wormy peaches left in the orchards last year, and the low mortality of adults during hibernation.

Visitors in May to the Bureau of Entomology peach-insect field laboratory, Fort Valley, Ga., included Jacques R. Faugeras, of the National Institute of Agronomy, Paris, France; B. P. Livingston, Director of the Alabama State Bureau of Plant Industry; P. H. Miller, in charge of the Arkansas State Plant Board; J. C. Dunegan, of the U. S. Bureau of Plant Industry, Fayetteville, Ark.; M. C. Swingle, of the Japanese Beetle Laboratory, Moorestown, N. J.; M. S. Yeomans, Georgia State Entomologist; and John B. Gill, of the Georgia State Board of Entomology.

Visitors to the Gipsy Moth Laboratory, Melrose Highlands, Mass., in May, were Dr. H. W. Allen, and G. J. Haeussler, of the field laboratory at Moorestown, N. J., May 2; B. J. Landis, of the field laboratory for investigations of the Mexican bean beetle, Columbus, Ohio, May 4; R. W. Burrell, of the Japanese Beetle Laboratory, Moorestown, N. J., and Prof. J. A. Manter, of the Connecticut Agricultural College, and two of his entomological students, May 7. Mr. Landis spent several days at the laboratory familiarizing himself with the work being done with parasites.

Dr. F. C. Craighead, Bureau of Entomology, spent three days in Denver, Colo., in the latter part of April, conferring with J. M. Miller and J. C. Evenden. Plans were arranged for the conducting of investigative work for the coming summer and for the carrying on of certain projects in cooperation with the Forest Service. As a result of the increase in appropriation for the Division of Forest Insects for the coming fiscal year, a new field laboratory will be established at Portland, Oreg., with F. P. Keen in charge.

At the end of April, Messrs. F. F. Smith and A. R. Graham collected over 5,000 cocoons of the larch sawfly, at St. Williams, Ontario. By the end of May, 31 adults of the parasite *Mesoleius tenthredinis* had emerged. This is highly encouraging as only a small number of the parasites were liberated in the St. Williams district, in June, 1927, and the recovery of the species in numbers indicates that the parasite has successfully established itself. A number of the emerging parasites have been liberated at Belleville, Ont.

In accordance with arrangements completed previously, Dr. W. Schaus, Division of Taxonomy, Bureau of Entomology, went to Brooklyn, N. Y., for the week of April 8 to 15, to examine the Lepidoptera which the Brooklyn Museum has decided to deposit in the United States National Museum Collection. He brought back by hand several hundred types which he had picked out of the collections. The cases containing the remainder of the specimens, some 65,000 in all, have been shipped to Washington by truck and will be installed in the Division of Insects at once.

J. R. Douglass, Bureau of Entomology, in charge of the field laboratory at Estancia, N. M., who has spent two months at the field laboratory at Columbus, Ohio, visited Washington April 9 to 13, and consulted with bureau officials regarding his work in New Mexico. Mr. Douglass is preparing a manuscript on the effects of rainfall and

temperature on the winter survival and spring emergence of the Mexican bean beetle at various altitudes and in different life zones. En route to Estancia he visited the field laboratory for the study of cotton insects at Tallulah, La.

Preparations have been completed at Westree, Ont., in connection with airplane dusting experiments in the control of the spruce budworm. Messrs. M. B. Dunn and Harry Fleming, Entomological Branch, left Ottawa for Westree at the end of May to lay out the experimental plots. The dusting work which is being conducted in cooperation with the Royal Canadian Air Force and the Provincial Forestry Branch, will be carried out during the last two weeks of June under the personal direction of Dr. J. M. Swaine. Biological investigations on the budworm are being continued in this section.

Lead arsenate, in the form of a top dressing, applied to turf for the control of Japanese beetle larvae, is being extensively used in the infested area this spring. On the Lansdowne, Pa., golf course the putting greens were treated with it in the autumn of 1928 and again in the spring of 1929. Lead arsenate was applied at the rate of 3 pounds to 1,000 square feet for each treatment. Examination of the turf on April 30 revealed no living larvae. The degree of infestation in the autumn of 1928 was more than 35 larvae to each square foot.

The twenty-first annual meeting of the Quebec Society for the protection of Plants was held at Macdonald College, Que., on April 17. Mr. C. E. Petch, presided at the meeting and the following Branch officers were also present, several of whom presented papers: Messrs. Arthur Gibson, W. N. Keenan, H. G. Crawford, G. H. Hammond, W. St. G. Ryan, A. G. Dustan, and C. R. Twinn. The meeting was well attended, and interesting, the major portion of the programme consisting of a symposium on recent developments in insecticides and fungicides. An address on the protection of trees from insect pests was delivered in the evening by Dr. E. P. Felt, formerly New York State Entomologist, now with the Bartlett Tree Research Laboratories.

Dr. J. M. Aldrich, Associate Curator of the Division of Insects, United States National Museum, left New York on May 15 for London, where he will spend some weeks in the study of muscoid types in the British Museum. At the conclusion of this work he will proceed to northern Norway and Sweden on a collecting expedition, the object being to obtain insects of northern Europe, especially Diptera, for comparison with similar forms occurring in the northern part of North America. While in Europe Dr. Aldrich will also visit some other museums for the purpose of examining types of muscoid Diptera. He expects to return to Washington about August 20.

A shipment of approximately 30,000 cocoons of the oriental moth, *Cnidocampa flavescens* Walk., reached the Gipsy Moth Laboratory, Melrose Highlands, Mass., on April 29. These were collected in Japan by T. R. Gardner, of the Japanese Beetle Laboratory, Yokohama, through the cooperation of Dr. A. L. Quaintance and Mr. L. B. Smith. The oriental moth is well established in Boston, Mass., and vicinity, having been first observed there in 1906. Rather large collections of larvae and pupae made in recent years have indicated that parasitism there is negligible; and the shipment of cocoons from Japan was made as an attempt to establish where needed in this country parasites that attack it in the Orient, especially a tachinid, *Chaetexorista javana* B & B.

A Mexican bean beetle tour was held on the 27th and 28th of June starting at Ridgely, Maryland, and proceeding through Cordova to the fields of the Talbot Packing Company; Hurlock, to visit the fields owned by W. H. Neal and Sons; Fruitland where the fields of the John H. Dulany and Sons Company were visited; and the large market bean section around Princess Anne. The following men made the trip: Messrs. T. B. Symons, Neale F. Howard, W. H. White, L. W. Brannon, C. H. Brannon, Robert Burdette, Professor Nissley, T. J. Headlee, T. H. Manns, H. L. Dozier, W. A. Whitney, E. N. Cory, P. D. Sanders, W. M. Dixon, Harry Kemp, E. W. Jenkins, L. M. Goodwin, A. D. Radebaugh, Frank Shook, M. D. Vane, E. W. Jenkins, J. S. Horton, M. G. Warren, L. R. Chiswell, C. H. Whitby, Earle Withgott, George Lamb, R. W. Purcell, McSherry Lupton, C. W. Smith, T. D. Holder, R. S. Brown, W. R. McKnight, William McKnight, Warren Newton, A. V. Neal, Morris Adams, C. Z. Keller, Harry Cannon, Walter McPherson, Ralph Dulany and Ernest Disharoon.

W. G. Bruce, Bureau of Entomology, of the field laboratory at Fargo, N. D., did considerable traveling during April in North Dakota and Minnesota, in the course of his investigations concerning cattle grubs. While in St. Paul, Minn., he conferred with members of the State experiment station and extension staffs on certain phases of the problem.

Mr. C. R. Twinn, Entomological Branch, visited Orillia and Camp Borden, June 2-6, in connection with local mosquito control projects and faunal studies. At Orillia, Mr. Twinn addressed a meeting of the Executives of the Orillia control committee and representatives of the local Board of Trade and public service organizations. While at Camp Borden he made an aerial survey of the breeding places surrounding the camp.

An extensive mosquito control campaign was conducted in the Ottawa, Ontario district again this year under the advice and direction of the Branch. Breeding areas occurring over an area of at least 25 square miles were dealt with, involving the distribution of over 7,000 gallons of oil. A small percentage of the infestation escaped the activities of the control workers, but otherwise the campaign was a marked success.

Upon the invitation of Captain R. G. Heiner, Marine Corps, U. S. Navy, F. C. Bishopp, Bureau of Entomology, gave an illustrated lecture on flies and their control before a class of naval and marine medical officers at Quantico, Va., May 14. The class was then conducted over the reservation for a study of the local situation as regards flies and was given instruction as to how different practical problems might be met.

F. C. Bishopp, Bureau of Entomology, left Washington April 3rd, for Los Angeles, Calif., where he appeared as a witness in court in a case involving alleged infringement of the Insecticide Act by the manufacturer of a proprietary insecticide. Later he conferred with Prof. W. B. Herms and others, at the University of California, and then went to the Coachella Valley in California, where a new field laboratory is being established for the study of the eye gnat, a species of Hippelates, which is a serious pest of man in that locality. On his return trip he visited the field laboratories at Tucson, Ariz., and El Paso, Uvalde, Sonora, Menard, and Dallas, Tex., and reached Washington, April 28.

The Dominion government on July 2 revised Canadian Quarantine Regulation No. 4 relating to the Mediterranean fruit fly. Under the new order the importation into the Dominion from Florida and from the Hawaiian Islands "of all plants, non-canned fruits or other plant products* * * is prohibited unless such importations are accompanied by a certificate* * * to the effect that the contents of the shipment originated in a district known to be free from infestation by the Mediterranean fruit fly." Pineapples, bananas, and coconuts may be imported from Hawaii under certificate of freedom from infestation of the products themselves.

The Mediterranean fruit fly by July 15 had been found in the following Florida counties: Brevard, Duval, Flagler, Hernando, Hillsborough, Lake, Levy, Marion, Orange, Osceola, Pinellas, Polk, Putnam, Seminole, St. Johns, Sumter and Volusia. Eradication operations have been pressed vigorously under the immediate personal direction of Dr. Wilmon Newell, acting for both the Federal Department and the State of Florida.

Recent changes in the nursery inspection and quarantine regulations of the State Plant Board of Mississippi include (1) an amendment to allow the shipment without fumigation of pecan trees from nurseries where injurious pests are not found; (2) a requirement that Mississippi-grown fruit trees and shrubs which are transported without having been inspected by State Officers are required to bear on each package a special Plant Board tag on which the shipper signs a statement that the contents are forest trees and shrubs only; (3) an amendment to the sweet potato weevil quarantine to include the entire State of Florida instead of naming the known infested counties as heretofore, and (4) an amendment to the rule governing sugar cane shipments into Mississippi to allow shipments from sections infested with sugar cane pests after such shipments have been properly treated to destroy the pests.

The Missouri Legislature, which has just recently adjourned, officially abolished the Missouri State Plant Board and has transferred the State Plant Act of 1925 over to the Missouri State Board of Agriculture for enforcement. After the first of September the State Board of Agriculture will be in charge of all plant inspection and quarantine regulation in Missouri. The executive officer in charge of the work will be known as the Plant Commissioner under the State Board of Agriculture with offices at Jefferson City, Missouri. The selection of the Plant Commissioner has not yet been announced but the Board is expected soon to select the man. Hereafter, therefore, the members of the Department of Entomology in the College of Agriculture at Columbia will be relieved of all regulatory work and will be free to devote their entire time to college and experiment station work.

Mr. H. J. Grady, Field Entomologist of the California Spray Chemical Co., spent several days in Nebraska recently during which time he, together with State Nursery Inspector, Mr. L. M. Gates, visited several of the nurserymen of this State advising with them in the control of the Pine Leaf Scale. He also made a trip to the Nebraska National Forest at Halsey, Nebrasks, together with State Nursery Inspector, Mr. L. M. Gates, to make an investigation of the Pine Tortoise Scale, *Toumeyella numismaticum*, which is doing serious damage to Jack Pine and Scotch Pine in the Sand Hills plantings in that vicinity. The Nebraska Department of Agriculture has purchased a power sprayer and will make some demonstration sprayings to aid the landowners in their efforts to control this scale.

The enforcement of the car-cleaning requirements under the Mediterranean fruit fly quarantine was handled largely by the transit inspection personnel of the Plant Quarantine and Control Administration. Under these requirements railway cars which have been used in transporting host fruits and vegetables must be cleaned at the unloading point. Mr. R. A. Sheals was in general charge in the field. The work in the Central States was carried out under the immediate direction of Mr. J. M. Corliss; the Pittsburg-Cleveland-Rochester territory was handled by Mr. G. W. R. Davidson; the vicinity of New York City was covered by Mr. C. E. Baker, and the New England States by Mr. M. E. Connolly. The movement of Florida products had practically ceased by the end of June, on which date Mr. Connolly resigned to return to his summer duties with the New Hampshire blister rust control office.

Two new plant quarantine stations were established by the California State Department of Agriculture on April 28. They are located on the Pacific highway near Hornbrook and on the Redwood highway near Crescent City, respectively. Additional new stations were inaugurated during May near Dorris in Siskiyou County, on the roads leading from Malin and New Pine Creek in Oregon, and near Cedarville in Modoc County, respectively. According to the Monthly Bulletin of the Department, these stations will be operated primarily for the purpose of preventing the entry into California of Florida citrus fruits and other fruits which are in violation of the California quarantine regulations or which may be the means of introducing into California the Mediterranean fruit fly or any other serious insect pest or disease.

The Secretary of Agriculture on July 8, announced the appointment of a committee of specialists to study and report on the fruit fly in Florida. He pointed out that he believes his Department specialists are as competent to pass judgment on the problem as any others obtainable, but in view of the enormous expenditures now clearly shown to be needed to continue the campaign of eradication, and the nation-wide concern in the problem he feels that he should have the benefit of the judgment of specialists outside of the Department of Agriculture best able to render an opinion on the possibility of a successful conclusion of the campaign. The specialists met in Washington on July 8 and proceeded to Florida on the same evening to make an intensive study of the situation. Those appointed on the committee were as follows: Vernon Kellogg, Washington, D. C.; H. A. Morgan, Knoxville, Tenn.; T. P. Cooper, Lexington, Ky.; Victor R. Gardener, East Lansing, Mich.; T. J. Headlee, New Brunswick, N. J.; G. A. Dean, Manhattan, Kansas, and H. J. Quayle, Riverside, Calif.

Official orders issued by the Plant Quarantine and Control Administration, relating to the prevention of spread of the Mediterranean fruit fly, include (1) Circular PQCA-226, prescribing the method of car-cleaning required under regulation 7 of the fruit fly quarantine; (2) Circular PQCA-229, under which it is ordered that further permits will not be issued for the movement of host fruits and vegetables from any part of the State of Florida into 18 southern and western States or into the Territory of Porto Rico; (3) a revision of Quarantine No. 68 and the rules and regulations supplemental thereto, effective June 7, under which the reshipment of host fruits and vegetables which have been produced in or moved from the State of Florida into the same southern and western States and Territory, is prohibited; (4) Circulars numbered PQCA-228, 233, 234 and 236, relating to the dates and conditions under

which host fruits and vegetables may move from protective zones, and (5) Circular PQCA-232, with respect to the movement from the State of Florida or through that State of imported fruits and vegetables. An additional order included in circular PQCA-234 provided that nursery stock shall not be shipped by mail from any part of the State of Florida.

Horticultural Inspection Notes

Mr. M. C. Rich, formerly stationed at San Ysidro, Calif., was transferred to the port of New Orleans on June 9, 1929.

Mr. Armen H. Bulbulian was appointed Junior Plant Quarantine Inspector July 1, 1929, and was assigned to duty at the port of New York.

Scouting to determine the spread of the European corn borer was begun July 1 and the full force was in the field by July 15.

Mr. Edward K. Vaughan, a graduate of New Mexico A. & M. College, was appointed Junior Plant Quarantine Inspector July 1, 1929, and was assigned to the port of El Paso, Texas.

A tropical species of mite, *Tarsonemus latus*, heretofore known from Florida and the West Indies and from greenhouses in Washington, D. C., has recently been reported injuring greenhouse plants in Connecticut.

The Nebraska Nursery Inspection Law was amended during the past session of the Legislature, so as to make June 1st the beginning of the inspection season instead of July 1st, as it had been in former years.

According to the report of the Connecticut State Entomologist for 1928, no European corn borers were found last year in the towns of Milford and Oxford, where the previous infested corn and weed areas were burned over in 1927.

A proposed building code for insuring protection of dwellings against termites and decay is included in a paper by Thomas E. Snyder, published in the Quarterly Bulletin of the State Plant Board of Mississippi for April, 1929.

Mr. Paul B. Mott, on July 1 assumed charge of the white pine blister rust work in New Jersey, under a cooperative appointment between the New Jersey State Department of Agriculture and the Bureau of Plant Industry of the United States Department of Agriculture.

Mr. R. A. Sheals of the Plant Quarantine and Control Administration conferred with Mr. L. M. Gates, State Nursery Inspector of Nebraska, at Omaha, during April, in regard to the cooperation of the State and Federal Departments on transit inspection at that point.

Among recently reported pest interceptions by the horticultural commissioners of California is one in which persimmons were found infested with the so-called root borer, *Sannina uroceriformia*. The infested seedlings are said to have been grown in Alabama.

The California State Department of Agriculture reports that as a result of the Endosepsis campaign in 1928 the percentage of internal rot infection in figs for the State was reduced from about 95% in 1928 to between 16 and 17% in the spring of 1929.

Mr. J. D. Winter has been appointed assistant State Entomologist and Chief Inspector in Minnesota effective July 1, 1929, and will be in direct charge of nursery inspection work. The present staff of inspectors are T. L. Aamodt, George W. Nelson and Vincent F. Peterson.

The methods of using lead arsenate in the soil as a permanent or semi-permanent protection against Japanese beetle infestation are described in Plant Quarantine and Control Administration circular PQCA-239, which was issued on July 8 as an amendment to PQCA-224.

The establishment of direct service between the Hawaiian Islands and Portland, has necessitated the enlargement of the port inspection work at that point. Mr. T. J. Baker continues in charge of the work, representing both the United States Department of Agriculture and the Oregon State Board of Horticulture.

A directory of field activities of the Plant Quarantine and Control Administration has been issued as Miscellaneous Publication No. 47. The names, addresses and duties of the employees of the Administration in the 27 States and two Territories where headquarters are maintained, are included.

Mr. Martin E. Connolly of the Plant Quarantine and Control Administration has been appointed collaborator by the Nebraska State Department of Agriculture, to enable him to cooperate with the State Department in inspecting uncertified nursery stock in connection with his duties at Omaha for the Federal department.

The California State Department of Agriculture issued a quarantine regulation effective June 27, restricting the intrastate movement of walnuts, walnut shells, and certain other articles, from parts of Los Angeles and San Bernardino counties where the black walnut fly *Rhagoletis juglandis* has been found.

Mr. R. A. Sheals, in charge of field activities in white pine blister rust quarantine enforcement in the Eastern States for the Plant Quarantine and Control Administration, was transferred from Providence, R. I., to Washington, D. C., on July 1. Three months previously he had been promoted from Agent to Associate Plant Quarantine Inspector.

The Federal European corn borer quarantine office has recently issued a booklet entitled "Instructions to Quarantine Line Inspectors." The booklet discusses the duties of the inspectors; the maintenance of quarantine stations; the method of handling violations, and the correct methods of sending in corn borer specimens.

Prof. A. G. Ruggles, State Entomologist of Minnesota, reports that during the spring of 1929 a total of 12,482 express and freight shipments of nursery stock were inspected in transit by inspectors of the State Department of Agriculture. Of this number 47 shipments were returned to the sender and four shipments were seized and destroyed.

The California State Department of Agriculture, on June 19, 1929, issued Quarantine Order No. 13 (New Series), relating to the Ozonium root rot. The order regulates the movement of all nursery stock and other plants, not including cuttings free from soil, from the States of Arizona, Texas, Oklahoma, and New Mexico, into California.

Dr. J. R. Eyer, Station Entomologist of the New Mexico College of Agriculture and Mechanic Arts, spent part of June and July making inspections in various

sections of New Mexico to determine whether there might be Mediterranean fruit fly infestation in the State, and examining railway cars suspected of having contained Florida host fruits and vegetables.

The Biennial Report of the Wisconsin Department of Agriculture for the years 1927 and 1928, which has just been published, includes a description of a new plan of nursery certification and the methods of issuing permits and shipping tags. The plant quarantine and special regulations are given in full. It also includes a progress report on a gladiolus disease investigation carried out by the associate pathologist.

The Federal Japanese beetle control office has placed Geraniol traps at outlying points of supposed infestation where adult beetles were captured by the scouts last season. The beetles captured in the traps are gathered about three times a week and the number of beetles recorded. Results during the first few days of operation in June indicated that the traps were highly efficient in attracting the insects. Mr. O. K. Courtney is in charge of the trapping work for the office.

Mr. P. A. Hoidale, heretofore in charge of the Mexican fruit worm eradication work in Texas, was transferred to Atlanta in May to direct the scouting and other Mediterranean fruit fly quarantine enforcement activities in the cotton belt States north of Florida. No Mediterranean fruit fly infestation has been found outside Florida as a result of this work. Such shipments of Florida fruit as have been found infested outside the State, all left Florida before the fly was first discovered at Orlando on April 6.

The Florida State Mediterranean fruit fly quarantine regulations, originally issued on April 15, were amended on April 29, May 4, May 13, June 8 and June 17. The amendments in most cases consisted of extensions of the "areas in which the Mediterranean fruit fly is known to occur or is likely to occur." The order of June 8 further added Rules 44 and 45, prohibiting the importation of stone fruits into Florida, and relating to the destruction of host plants on abandoned and uncared for properties, respectively.

Mr. E. C. Mandenberg, In Charge of Nursery and Orchard Inspection, Lansing, Mich., reports that eight inspectors are now employed in that State on orchard and nursery inspection. By the latter part of June, 1300 acres of raspberries had been covered. The raspberry plantings of Michigan were found to show less disease infection than ever before. The improvement seems to have resulted in part at least from the early start of the inspection work last season. In addition to the nursery inspectors, 13 men are employed on white pine blister rust activities under a State leader.

Apicultural Notes

The Maryland State Beekeepers Association met on the 22nd of June at the home of Mr. Lloyd B. Sherman, Glenarm, Maryland. The principle address of the afternoon was made by Mr. N. W. James.

Mary L. White, who has been employed at the Bee Culture Laboratory of the Bureau of Entomology for several summers, has been reappointed as temporary Field Assistant to assist in the bee disease work. Willis R. Doyle also has been appointed temporary Field Assistant.

The officers and executive committee of the Alabama Beekeepers Association met at Montgomery, June 20, and voted to have their next annual meeting November 7th and 8th at Montgomery. All beekeepers are invited to attend this meeting. The Alabama Beekeepers Association also entered the American Honey Producers' League.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology included: Mr. Henry Brown, of Cape May Court House, New Jersey, one of the largest commercial beekeepers in that State; and Mr. Aubrey V. Smith, of Phoenix, Arizona, also a large commercial beekeeper.

Prof. L. M. Bertholf, Professor of Biology, Western Maryland College, has returned to the Bee Culture Laboratory of the Bureau of Entomology to continue his work on reactions of the honeybee to light. He is devoting his attention this summer mainly to the response of bees to ultra-violet light and its physiological effects on them.

The honorary degree of Doctor of Science was conferred on Professor E. F. Phillips of Cornell University at the annual commencement of Allegheny College, Meadville, Pennsylvania, in June. This is the first such degree conferred by the College and comes on the thirtieth anniversary of Professor Phillips' graduation from the College.

The third annual summer tour of the Illinois State Beekeepers' Association will be held on July 24–26, visiting beekeepers along the eastern and southern border of the state. Prominent beekeepers will be included in the itinerary and their systems of management explained and discussed. Assisting with the tour will be Mr. A. L. Kildow, State Apiary Inspector, V. G. Milum, in charge of Apiculture at the University of Illinois and representatives of the bee supply manufacturers.

The Southern States Bee Culture Field Station, at Baton Rouge, La., is very grateful to receive as a gift practically complete files of the American Bee Journal and Gleanings in Bee Culture, from Prof. H. B. Parks, Apiculturist at the Texas Agricultural Experiment Station, San Antonio. This addition is a very welcome one and it will form the nucleus for a beekeeping library which will be available not only to the scientific workers in apiculture in the Southern States, but to beekeepers as well.

The Press Service of the Department of Agriculture announced on May 31st that arrangements had been made to include chemical tests of honey where official United States grade certificates are desired. At the present time the chemical tests will be made by the Food Products Inspection Service of the Bureau of Agricultural Economics. This does not apply to samples which are graded without charge merely for color, but to lots which are to have inspection certificates. The press release should be consulted for further details.

A new corn sugar bill was introduced by Representative Cole of Iowa, H. R. 2154, on April 29. Arrangements were at once made to organize the beekeepers of the country against this legislation. In the two previous Congresses, similar legislation has been prevented through the activities of beekeeping organizations and beekeepers. Since the commercial development of beekeeping has been possible because of the enactment and efficient enforcement of the food and drugs act of June 30, 1906, beekeepers oppose any attempt to weaken and to destroy this act.

Miss Vajen E. Hitz has been temporarily transferred from the Library of the Department of Agriculture to the Bee Culture Laboratory of the Bureau of Entomology

to prepare a catalogue of the beekeeping literature. It is planned to issue the catalogue in mineographed form so that those interested may obtain a record of the beekeeping literature in the Bee Culture Library. Several of the beekeeping libraries have already made valuable contributions to the Bee Culture library and have generously offered to assist in making available at Washington as complete a collection of literature on beekeeping as possible.

The Apicultural Research Laboratory, A. & M. College, Texas, sent an expedition to the Big Bend Country, the last two weeks in June to study the honey plant situation, and to bring back living plants and seeds for the honey plant collection at the laboratory. This expedition was under the guidance of Mr. A. H. Alex, Queen Breeder. The expedition visited Mr. A. B. Anderson at Marathon, who is perhaps the largest beekeeper in that section of the State. Mr. Anderson operates an up-to-date apiary and produces honey in car-load lots. His chief source of honey is catsclaw and Mexican persimmon. The century plants give him quite an amount of honey but it is of poor quality.

In connection with the 51st annual meeting of the American Library Association held in Washington on May 13–18, the Library Staff of the United States Department of Agriculture served luncheon on May 15th to the members of the Agricultural Libraries Section. This luncheon was of particular interest because all the food for it was produced and prepared in the Department. Honey, furnished by the Bee Culture Laboratory of the Bureau of Entomology, occupied a prominent place on the menu, orange blossom, white clover, and tulip-tree honeys being used. The ice cream, made by the Bureau of Dairy Industry, was flavored and sweetened entirely with orange blossom honey. The market for ice cream flavored with orange blossom honey appears exceptionally bright.

Arrangements have been made to have a set of the abstracts prepared by Mr. B. P. Uvarov for the compilation of his recent work on Insect Nutrition and Metabolism files in two libraries in Great Britain for the use of interested workers. A similar set of these abstracts will shortly be sent to Cornell University for the use of American workers in this field. This set is sent through the courtesy of the Committee on Civil Research of Great Britain. When received these abstracts will be made available through the library exchange to men of other institutions in the United States and Canada who may find use for them. Those interested may in the meantime get additional information by writing Dr. E. F. Phillips.

Dr. S. W. Bilsing, Head of the Department of Entomology A. & M. College of Texas, and Prof. V. A. Little, Professor of Entomology in the same institution were in San Antonio June 7th, attending the meeting of the Texas Entomological Society. June 8th, they visited the State Apicultural Research Laboratory, and in conference with H. B. Parks, Chief of the Division of Apiculture and A. H. Alex, Queen Breeder, made plans for the Beekeepers meeting at the Short Course which is held every summer at the A. & M. College of Texas. The meeting this year will be a very important one. The first two days will be conducted by the State Beekeepers Association, the third day by the Queen Breeders Association, and on the fourth day a group of beekeepers interested in the formation of a marketing association will attempt a preliminary organization. A meeting for forming the permanent organization has been called for September; the place of meeting to be at San Antonio.

The Maryland Beekeepers' Association held a field meeting at the apiary of the Bee Culture Laboratory, Somerset, Maryland, on May 25th. Mr. F. G. Robb and Mr. H. J. Clay of the Bureau of Agricultural Economics gave short addresses, as well as several members of the Bee Culture staff. Mr. Rieth, an international student at Johns Hopkins University, and one of the commercial beekeepers in the Hamburg area of Germany, gave an interesting talk on German beekeeping. A complicated patented German beehive, recently received as a gift at the Laboratory, was exhibited. Mr. Rieth pronounced it too complicated and not typical of German beehives. An interesting contest was arranged, each beekeeper demonstrating his expertness in filling a queen-bee mailing cage with bees. Ten beekeepers finished the contest, the remainder being disqualified because of being stung. The Maryland State Beekeepers' Asosciation awarded the prizes, the queen bee going to Mr. Rieth, and Mr. Aman receiving a certificate as the most expert Maryland beekeeper. Members of the Bee Culture staff demonstrated some of the work at the Laboratory.

Notes on Medical Entomology

Mr. G. H. Fisk, temporary Insect Pest Investigator, Entomological Branch, reported for duty at Ottawa on May 18 and is engaged in mosquito and housefly investigations.

J. L. Webb, Bureau of Entomology, made a trip to New York on May 14 to consult with a representative of the Sumatra Caouchouc Company, the principal company engaged in exporting derris roots from Sumatra.

On May 9, W. E. Dove, Bureau of Entomology arrived in Washington from his station at Dallas, Tex., to consult bureau officials and specialists in the National Museum. He returned to Dallas after spending two weeks in Washington.

On May 20, D. C. Parman, Bureau of Entomology, returned for a short period to his official headquarters at Uvalde, Tex., from Coachella, Calif., where he has been engaged in studies of the eye gnat, a species of Hippelates.

W. V. King, Bureau of Entomology, writes from Manila, where he is investigating the malaria mosquitoes of the Philippine Islands, under the auspices of the International Health Board, that he expects to return to his duties at Mound, La., about June 15.

Errata

An error occurs in the notations besides the formulas in the article "Determining Hydrocyanic Acid Gas Concentration in Fumigation Experiments" by C. O. Eddy and E. N. Geddings on page 371 of the April 1929 Journal of Economic Entomology. 0.054=AgI titer in mg. should read 0.054=HCN equivalent of each cc. of suspension. The proper explanation is given in the last sentence of the second full paragraph on that page.